

Magnetism Review Questions & Solutions Chapters 36 & 37

Chapter 36

Review Questions

1. What do electric charges have to do with magnetic poles? (36.1) **They both attract and repel**
2. What is a major difference between electric charges and magnetic poles? (36.1)

Charges can be isolated, whereas poles cannot

3. What is a magnetic field, and what is its source? (36.2)

Altered space around a magnet; moving electric charges

4. Every spinning electron is a tiny magnet. Since all atoms have spinning electrons, why are not all atoms tiny magnets? (36.3) **Electrons spin in opposite directions, so their fields cancel out**
5. What is so special about iron that makes each iron atom a tiny magnet? (36.3)

Fields of iron's electrons do not entirely cancel

6. What is a magnetic domain? (36.4) **A cluster of aligned atoms**
7. Why do some pieces of iron behave as magnets, while other pieces of iron do not? (36.4)

Domains in some are aligned

8. How can a piece of iron be induced to become a magnet? For example, if you place a paper clip near a magnet, it will itself become a magnet. Why? (35.4) **Align the domains with the magnetic field**
9. Why will dropping or heating a magnet weaken it? (36.4) **The domains are jostled out of alignment**
10. What is the shape of the magnetic field that surrounds a current-carrying wire? (36.5)

Concentric Circles

11. If a current-carrying wire is bent into a loop, why is the magnetic field stronger inside the loop than outside? (36.5) **The fields overlap inside the loop**
12. What must a charged particle be doing in order to experience a magnetic force? (36.6)

Moving across magnetic field lines

13. With respect to an electric and a magnetic field, how does the direction of a magnetic force on a charged particle differ from the direction of the electric force? (36.6)

Magnetic – force is perpendicular to the field; electric – force is parallel to the field.

14. What role does Earth's Magnetic field play in cosmic ray bombardment? (36.6)

It deflects incoming charged cosmic rays.

15. How does the direction in which a current-carrying wire is forced when in a magnetic field compare with the direction that moving charges are forced? (36.7) **Same**
16. How do the concepts of force, field and current relate to a galvanometer? (36.8)

Force acts on the current in the field and deflects the galvanometer coil

17. Why is it important that the current in the armature of a motor that uses a permanent magnet periodically change direction? (36.8) **So it will do more that rotate 180°**
18. What is meant by magnetic declination? (36.9)

Difference between geographic north and magnetic north

19. According to most geophysicists, what is the probably cause of Earth's magnetic field? (36.9)

Currents in Earth's molten interior

20. What are magnetic pole reversals, and what evidence is there that Earth's magnetic field has undergone pole reversals throughout history? (36.9) **N Changes to S, S to N; magnetism found in rock strata**

Think and Explain (Extra Credit)

21. What kind of field surrounds a stationary electric charge? A moving electric charge? **An electric field; electric and magnetic fields**
22. Why can iron be made to behave as a magnet, while wood cannot? **Iron, unlike wood, has magnetic domains that can be induced into alignment.**
23. Since iron filings are not themselves magnets, by what mechanism do they align themselves with a magnetic field as shown in figure 36.6? **Magnetic domains in the filings are induced into alignment along the external magnetic field lines. This produces poles in the filings, which are then acted on**

by the external field, resulting in a torque on each filing. The torque produces a “couple” that aligns the filing with the field.

24. A strong magnet and a weak magnet attract each other. Which magnet exerts the stronger force on the strong one or the weak one? (Could you have answered this way back in chapter 6?) **The forces in a force pair in any interaction are equal and opposite**
25. Why will the magnetic field strength be further increased inside a current-carrying coil if a piece of iron is placed in the coil? **The alignment of domains adds to the field strength**
26. A cyclotron is a device for accelerating charged particles to high speeds in circular orbits of ever-increasing radius. The charged particles are subjected to both an electric field and a magnetic field. One of these fields increases the speed of the particles, and the other field holds them in a circular path. Which field performs which function? **The electric field increases the speed of an electric charge (force on the charge can be in the direction of motion). The magnetic force always acts perpendicular to the motion of the charge, so the force changes the direction of the charged particles path**
27. A magnetic field can deflect a beam of electrons, but it cannot do work on them to speed them up. Why? (Hint: consider the direction of the force relative to the direction in which the electrons move) **There is no component of magnetic force in the direction of motion**
28. In what direction relative to a magnetic field does a charged particle travel in order to experience maximum magnetic force? Minimum magnetic force? **Perpendicular to the field lines; parallel to the field lines**
29. Pigeons have multiple-domain magnetite magnets within their skulls that are connected through a large number of nerves to the pigeons brain. How does this aid the pigeon in navigation? (magnetic material also exists in the abdomen of bees) **It likely allows them to sense the direction of the Earth's magnetic field.**
30. What changes in cosmic ray intensity at Earth's surface would you expect during periods in which Earth's magnetic field passed through a zero phase while undergoing pole reversals? (A widely held theory, supported by fossil evidence, is that the periods of no protective magnetic field may have been as effective in changing life forms as X-rays have been in the famous heredity studies of fruit flies.) **Increased intensity of cosmic rays**
31. Earth's core is probably composed of iron and nickel, excellent metals for making permanent magnets. Why is it unlikely that Earth's core is a permanent magnet? **It is too hot for iron and nickel to be magnetic**
32. Can an electron be set into motion with a magnetic field? With an electric field? Explain. **No, no force on a stationary charge; yes**

Chapter 37

Review Questions

1. What did Michael Faraday and Joseph Henry discover?
Electric current can be produced in a wire by motion of a magnet
2. How can voltage be induced in a wire with the help of a magnet?
By moving the magnet past the wire or into the coil
3. A magnet moved into a coil of wire will induce voltage in the coil. What is the effect of moving a magnet into a coil of wire with more loops?
Greater induced voltage
4. Why is it more difficult to move a magnet into a coil of more loops that is connected to a resistor?
The coil becomes a stronger electromagnet and repels more
5. Current, as well as voltage, is induced in a wire by electromagnetic induction. Why is Faraday's law expressed in terms of induced voltage and not induced current?
Current depends on resistance of a circuit
6. How does the frequency of a changing magnetic field compare with the frequency of the alternating voltage that is induced?

Same

7. What is a generator and how does it differ from a motor?

A motor converts electricity to work, whereas a generator converts work to electricity

8. Why is alternating voltage induced in the rotating armature of a generator?

The magnetic field increases and decreases each turn.

9. The armature of a generator must rotate in order to induce voltage and current. What causes the rotation?

External source of energy such as fuel, wind or water

10. A motor is characterized by three main ingredients: magnetic field, moving charges and magnetic force. What are the three main ingredients that characterize a generator?

Same

11. How can a change in voltage in a coil of wire (the primary) be transferred to a neighboring coil of wire (the secondary) without physical contact?

Induction by changing the magnetic field

12. Why does an iron core that extends inside and connects the primary and secondary coils intensify electromagnetic induction?

The domains of the iron core align and increase the number of magnetic field turns?

13. What does a transformer actually transform – voltage, current, or energy?

Voltage and current, but not energy

14. What does a step up transformer step up – voltage, current or energy?

Voltage

15. How does the relative number of turns on the primary and the secondary coil in a transformer affect the step-up or step-down voltage factor?

More turns on the secondary coil step up the voltage

16. If the number of secondary turns is 10 times the number of primary turns, and the input voltage to the primary is 6 volts, how many volts will be induced in the secondary coil?

60 V

17. In a transformer, how does the power input to the primary coil compare with the power output of the secondary coil? How does the produce of voltage and current in the primary compare with the product of voltage and current in the secondary?

Same; Same (as long as power loss is negligible)

18. Why is it advantageous to transmit electric power long distances at high voltages?

Lower current results in less energy loss through the heating of the wires, it is also much safer in terms of human and animal life and fire safety

19. What fundamental quantity underlies the concepts of voltages and currents?

Electric Field

20. Distinguish between Faraday's Law expressed in terms of fields and Maxwell's counterpart to Faraday's law. How are the two laws symmetrical?

Faraday's Law – Electricity induced by moving magnetism; Maxwell's – Magnetism induced by moving electricity; they are inverses or exact opposites of each other.

21. How do wave speeds compare for high-frequency and low-frequency electromagnetic waves?

The speeds are the same – c (see chapter 27 for review of electromagnetic wave speeds)

22. What is light?

Electromagnetic waves whose frequency range is from 400-700 nm

Think and Explain (Extra Credit)

23. A common pickup for an electric guitar consists of a coil of wire around a permanent magnet. The permanent magnet induces magnetism in the nearby guitar string. When the string is plucked, it oscillates above the coil, thereby changing the magnetic field that passes through the coil. The rhythmic oscillations of the string produce the same rhythmic changes in the magnetic field in the coil, which in turn include the same rhythmic voltages in the coil, which when amplified and sent to a speaker produce music! Why will this type pickup not work with nylon strings? **Nylon is nonmagnetic, has no magnetic domains, and is not magnetized by the permanent magnet**

24. What is the basic difference between an electric generator and an electric motor? **None, they simply operate in opposite manners**
25. With no magnets around, why will current flow in a coil of wire waved around in the air? **Waving the coil moves it through the earth's magnetic field, inducing voltage and hence current**
26. Why is it important that the core of a transformer pass through both coils? **To ensure the maximum number of magnetic field lines produced in the primary coil and intercepted by the secondary coil**
27. Why can a hum often be heard when a transformer is operating? **The hum is a same frequency force vibration of the iron slaps in the transformer core as their magnetic polarities alternate**
28. If a bar magnet is thrown into a coil of wire, it will slow down. Why? **The magnet will induce a current in the loop. The field produced by the current tends to repel the magnet as it approaches and attract it as it leaves.**
29. What is the source of all electromagnetic waves? **Accelerating electric charges**
30. Why is a generator armature more difficult to rotate when it is connected to and supplying electric current to a circuit? **The repulsion of the electromagnets opposes the rotation of the armature. The greater the current, the greater the repulsion, and the more work that must be done to spin the armature. The answer is implied by energy conservation. Work done in turning the armature goes into the electrical energy supplied to the external circuit.**
31. Some bicycles have electric generators that are made to turn when the bike wheel turns. These generators provide energy for the bike's lamp. Will a cyclist coast further if the lamp connected to the generator is turned off? Explain. **When the lamp is on, the energy that goes into lighting the lamp comes at the expense of the KE of the moving bicycle. The extra KE saved by not lighting the lamp makes the bicycle go farther.**
32. An electric hair drier running at normal speed draws a relatively small current. But if somehow the motor shaft is prevented from turning, the current dramatically increases and the motor overheats. Why? **A running motor always draws less net current than a stalled motor. If the motor jams or is somehow prevented from turning, then the back current is no longer generated and the net current in the motor windings is greater. This overheats the motor.**
33. When a piece of plastic tape coated with iron oxide that is magnetized more in some parts than others is moved past a small coil of wire, what happens in the coil? What is the practical application of this? **Variations in voltage, the principle that underlies the operation of a tape recorder.**
34. When a strip of magnetic material, variably magnetized, is embedded in a plastic card that is moved past a small coil of wire, what happens in the coil? What is a practical application of this? **Voltage is induced in the coil, the principle that underlies the operation of the device that checks a credit card.**
35. If a car made of iron and steel moves over a wide closed loop of wire embedded in a road surface, will the magnetic field of Earth in the loop be altered? Will this produce a current pulse? (Can you think of a practical application of this?) **Yes, Yes, triggering automobile traffic lights.**
36. How could you move a conducting loop of wire through a magnetic field without inducing voltage in the loop? **Move it in such a way that the number of field lines doesn't change**
37. Why does a transformer require alternating voltage? **AC provides the change needed for electromagnetic induction**
38. Can an efficient transformer step up energy? Defend your answer. **No. To do so would violate the law of energy conservation**
39. What is wrong with this scheme? To generate electricity without fuel, arrange a motor to run a generator that will produce electricity that is stepped up with a transformer so that the generator can run the motor while furnishing electricity for other uses. **It violates the law of energy conservation. Because of inherent inefficiencies, the generator will produce less electric power than is used to run the adjoining motor. A transformer will not step up voltage and current simultaneously.**