Electric and Magnetic Fields Review

2.3 Electric and Magnetic Fields

Be able to:

- solve vector problems involving Coulomb's Law
- calculate electric field intensity
  - due to a single point charge
  - due to multiple point charges
  - between parallel plates
- sketch electric fields
  - around a point charge (positive or negative)
  - between like charges
  - between unlike charges
  - between parallel plates
- calculate electric potential energy
- calculate potential difference
- solve problems involving charges moving parallel to an electric field
- solve problems for charges moving perpendicular to an electric field (using kinematics of projectile motion)
- calculate magnetic field intensity (B) around a current carrying wire
- calculate the magnitude of the force on a moving charged particle in a magnetic field
- solve circular motion problems involving a charge moving in a magnetic field
- apply the various right hand rules
- solve problems based on cathode ray tubes and mass spectrometers

Review Problems

1. Two charges, q_1 and q_2, are separated by a distance, d, and exert a force on each other. What new force will exist if d is doubled? ($\frac{F}{4}$)

2. Two charges, q_1 and q_2, are separated by a distance, d, and exert a force on each other. What new force will exist if q_1 and q_2 are both doubled? ($4F$)

3. Two identical point charges are separated by a distance of $3.0\ cm$ and they repel each other with a force of $4.0\times10^{-5}\ N$. What is the new force if the distance between the charges is doubled? ($1.0\times10^{-5}\ N$)

4. An electric force of $2.5\times10^{-4}\ N$ acts between two equally-charged spheres which are $2.0\ cm$ apart. Calculate the force acting between the spheres if the charge on one of the spheres is doubled and the spheres move to a $5.0\ cm$ separation. ($8.0\times10^{-5}\ N$)

5. Two identical charges are $3.00\ cm$ apart. Find the charge on each of them if the force of repulsion is $4.0\times10^{-7}\ N$. ($\pm2.0\times10^{-10}\ C$)

6. A charge of $4.0\times10^{-5}\ C$ is attracted by a second charge with a force of $350\ N$ when the separation is $10.0\ cm$. Calculate the size of the second charge. ($-9.7\times10^{-6}\ C$)

7. Three particles are placed on a straight line. The left particle has a charge of $+4.6\times10^{-6}\ C$, the middle particle has a charge of $-2.3\times10^{-6}\ C$, and the right particle has a charge of $-2.3\times10^{-6}\ C$. The left particle is $12\ cm$ from the middle particle and the right particle is $24\ cm$ from the middle particle. Find the total force on the middle particle. ($7.4\ N\ [left]$)

8. The left particle in the problem above is moved directly above the middle particle, still $12\ cm$ away. Find the force on the middle particle. ($6.7\ N\ [7.1°\ W\ of\ N]$)

9. A positive test charge of $6.5\times10^{-6}\ C$ experiences a force of $4.5\times10^{-5}\ N$. What is the magnitude of the electric field intensity? ($6.9\ N/C$)

10. It takes $8.00\ mJ$ to move a charge of $4.00\ \mu C$ from point **A** to point **C** in an electric field. What is the potential difference between the two points? ($2000\ V$)

11. How much work is required to move a positive charge of $2.5\ \mu C$ between two points that have a potential difference of $60\ V$? ($1.5\times10^{-4}\ J$)

12. A cloud has a potential difference relative to a tree of $900\ MV$. During a lightning storm, a charge of $100\ C$ travels through this potential difference. How much work is done on this charge? ($9.00\times10^{10}\ J$)

13. A constant electric field of $750\ N/C$ is between a set of parallel plates. What is the potential difference between the parallel plates if they are $1.5\ cm$ apart? ($11.25\ V$)

14. What is the electric field intensity between two large parallel plates $2.0\ cm$ apart, if a potential difference of $450\ V$ is maintained between them? ($22500\ V/m$)

15. What potential difference applied between two parallel plates will produce an electric field strength of $2.5\times10^{3}\ N/C$, if the plates are $8.0\ cm$ apart? ($200\ V$)

16. How far apart are two parallel plates if a potential difference of $600\ V$ produces an electric field intensity of $1.2\times10^{4}\ N/C$ between them? ($0.05\ m$)

17. An oil drop, of mass $2.6\times10^{-15}\ kg$, is suspended between two parallel plates $0.50\ cm$ apart, and remains stationary when the potential difference between the plates is $270\ V$. What is the charge on the oil drop, and how many excess or deficit electrons does it have? ($4.7\times10^{-19}\ C$, $\pm3\ electrons$)

18. A metallic ping-pong ball, of mass $0.10\ g$, has a charge of $5.0\times10^{-6}\ C$. What potential difference, across a large parallel plate apparatus of separation $25\ cm$, would be required to keep the ball stationary? ($49\ V$)

19. An electron is released from rest adjacent to the negative plate in a parallel plate apparatus. A potential difference of $500\ V$ is maintained between the plates, and they are in a vacuum. With what speed does the electron collide with the positive plate? ($1.33\times10^{7}\ m/s$)

20. An electron, of mass $9.1\times10^{-31}\ kg$ with a velocity of $5.0\times10^{6}\ m/s$ is injected into a parallel plate apparatus through a hole in the positive plate. It moves across the vacuum between the plates, colliding with the negative plate at $1.0\times10^{6}\ m/s$. What is the potential difference between the plates? ($-68\ V$)

21. A proton is moving to the right in a magnetic field whose direction is up the page. What is the direction of the force exerted by the magnetic field upon the proton?

22. An electron beam moving horizontally away from you is deflected toward the right after passing through a certain region of space that contains a constant magnetic field. What is the direction of the magnetic field?

23. A beam of electrons moving left at $3.0\times10^{7}\ m/s$ passes at right angles to a uniform magnetic field that is directed down the page and in which the magnetic field strength is $2.0\times10^{-4}\ T$. What force acts upon each electron in the beam? ($9.6\times10^{-16}\ N$ [into the page])

24. Electrons, moving at $8.5\times10^{7}\ m/s$, pass through crossed magnetic and electric fields undeflected. What is the size of the magnetic field if the electric field is $4.0\times10^{4}\ N/C$? ($4.7\times10^{-4}\ T$)

25. An electron is moving at $2.0\times10^{8}\ m/s$ in a constant magnetic field. How strong should the magnetic field be to keep the electron moving in a circle of radius 0.50 m? ($0.0023\ T$)

26. A beam of electrons, moving at $2.0\times10^{8}\ m/s$, passes at right angles to a uniform magnetic field of $41\ mT$. What is the radius of the circular path in which this beam will travel through the magnetic field? ($0.028\ m$)

27. An unknown particle is accelerated by a potential difference of $150\ V$. The particle then enters a magnetic field of $50.0\ mT$, and follows a curved path with a radius of $9.80\ cm$. What is the ratio of $\frac{q}{m}$? ($1.25\times10^{7}\ C/kg$)

28. A beam of doubly-ionized oxygen atoms is accelerated by a potential difference of $232\ V$. The oxygen then enters a magnetic field of $75.0\ mT$, and follows a curved path with a radius of $8.3\ cm$. What is the mass of the oxygen atom? ($2.67\times10^{-26}\ kg$)

29. A hydrogen ion is accelerated through an accelerating potential of $100\ V$ and then through a magnetic field of $50.0\ mT$ to standardize the mass spectrometer. What is the radius of curvature if the mass of the ion is $1.67\times10^{-27}\ kg$? ($0.029\ m$)