St John Baptist De La Salle Catholic School, Addis Ababa

Grade 10 Physics Midterm Examination Solutions

3rd Quarter

March, 2023

Notes, and use of other aids is **NOT** allowed. Read all directions carefully and **write your answers in the answer sheet**. To receive full credit, you must show all of your work.

Name:____________________ Roll Number:______ Section:____ Time Allowed: **50 minutes**

Multiple Choice Questions

1. Which of the following is not a ferromagnetic material?
   A. Neodymium B. Cadmium C. Iron D. Nickel E. N/A
   Answer: B

2. Which of the following particles below would have the largest radius of trajectory when shot into a uniform magnetic field with the same speeds?($m_p = 1.67 \times 10^{-27}kg$ & $m_e = 9.11 \times 10^{-31}kg$)
   A. An electron B. A proton C. A neutron D. A particle that has the same charge as a proton but half its mass E. N/A
   Answer: B

3. For two vectors $\vec{A}$ and $\vec{B}$ and an angle θ between them, which of the following is true?
   A. $\vec{A}\times\vec{B} = |\vec{A}||\vec{B}|\sin\theta$ B. $\vec{A}\times\vec{B} = |\vec{A}||\vec{B}|$ if $\vec{A}$ and $\vec{B}$ are parallel C. $\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta$
   D. $\vec{A}\times\vec{B}$ is perpendicular to $\vec{A}\cdot\vec{B}$ E. N/A
   Answer: C

4. What makes magnets distinct from charged bodies?
   A. In contrary to charged bodies, magnets have poles which attract when they're the same kind and repel when they are opposite.
   B. Magnets are moved by gravitational fields while charges are moved electric fields only.
   C. While charged particles can be found alone, magnetic monopoles are never found alone.
   D. Magnetic force on charged particles is in the same direction as the field while the electrical force is perpendicular to the electric field.

   Answer: C

5. A straight current carrying wire of length 5m has a current of 1 A passing through it. What is the magnitude force on the wire if it is placed in a magnetic field of 10 G such that the direction of the current flow is parallel to the magnetic field?
A. 5×10^{-3} N B. 0 N C. 5×10^{-3} N D. 1 N E. N/A
Answer: B

6. An electron enters a region of uniform magnetic field to the right. The magnetic field is going into the plane of this page. If the electron is moving at a speed of 1.5×10^6m/s and the magnetic field strength is 4.0 T, what is the magnitude of the force on the electron?($q_p = 1.6 \times 10^{-19}$C)
A. 9.6×10^{-13}N B. 5.8×10^{-13}N C. 9.6×10^{-12}N D. 5.8×10^{-12}N E. N/A
Answer: A

7. What is the magnitude of the $\vec{\mathbf{B}}$ of a straight current carrying wire 2 cm away if it is carrying 7A of current?($\mu_0 = 4\pi \times 10^{-7}\frac{Tm}{A}$)
A. 7×10^{-7} T B. 2×10^{-5} T C. 0.7 G D. $7\pi \times 10^{-3}$ T E. N/A
Answer: C

8. A magnet can be demagnetized by different ways. One of the common ways of achieving that is by heating up the magnet above a threshold temperature at which the magnetic domains will have been permanently disordered. What is this temperature called?
A. Boltzmann Temperature B. Rosie Temperature C. Curie Temperature D. Francis Arnold Temperature E. N/A
Answer: C

9. What is the maximum force on a conducting wire of length 3m carrying 2A of current when it is subjected to a magnetic field of $\frac{1}{6} \times 10^{-4}$ T?
A. 10^{-4} N B. 3×10^{-4} N C. 0 N D. -10^{-4} N E. N/A
Answer: A

10. The Northern Lights(*Aurora Borealis*) is caused by one of the following phenomenon.
A. Earth's Gravitational Field B. Earth's Magnetic Field C. Earth's Electric Field D. Sun's Magnetic Field E. N/A
Answer: B

11. The current in a current carrying wire flows into the page. What is the direction of the magnetic field due to this current carrying wire?
A. Upwards B. Downwards C. Clockwise D. Counterclockwise E. N/A
Answer: C

12. A negative charge moving to the right with a constant velocity enters a region of a uniform magnetic field pointing out of the page. What is the direction of the magnetic force on the charge?
A. Left B. Right C. To the top D. To the bottom E. N/A
Answer: C

13. Which of the following is true about the comparison between magnetic & electric forces on moving charges?
   A. The electric field lines show the actual direction in which a force acts on a charge while the magnetic field lines don't.
   B. Electric force is a non-contact force whereas magnetic force is contact.

C. Electric force is in the same direction to the electric field while the magnetic force is perpendicular to the field.

D. Electric force is contact force whereas magnetic force is non-contact force.

E. N/A

Answer: A/C

14. Which of the following properties is true about magnetic field?

A. The magnetic force between two magnets is greater when the distance between these magnets is greater.

B. Like poles repel while unlike poles attract.

C. Magnetic monopoles can rarely be found.

D. Magnetic poles always exist in pairs.

E. N/A

Answer: B/D

15. An electron and a proton were shot into a uniform magnetic field with the same speed perpendicular to it, which one has a lesser radius when traveling about a circle?

A. The proton

B. The electron

C. They have the same radius

D. We can't be sure until we perform the experiment

E. N/A

Answer: B

16. If a charged particle moves straight through a magnetic field, what can we say about the charge?

A. The charged particle could be moving parallel to the magnetic field.

B. The charged particle has a neutral charge.

C. The charged particle could be moving perpendicular to the magnetic field.

D. A & B

E. N/A

Answer: D

Work Out Problems

17. Calculate the force per unit meter exerted by two parallel current carrying wires going into the page carrying 1A of current each. Show that they attract each other when the current flowing in the wires is in the same direction.($\mu_0 = 4\pi \times 10^{-7} H/m$)

$$\otimes_A <---r---> \otimes_B$$

Each wire is carrying a current of 1A, so the magnitude of the magnetic field generated by each wire is the same.

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \frac{4\pi \times 10^{-7} H/m \times 1A}{2\pi r}$$

$$B = \frac{2 \times 10^{-7}}{r} Tm \text{ such that } r \text{ is the distance between the two wires}$$

However, the force is:

$$F = IlB \sin\theta = IlB$$

$$\frac{F}{l} = IB$$

$$\frac{F}{l} = 1A \times \frac{2 \times 10^{-7}}{r} Tm$$

$$\frac{F}{l} = \frac{2 \times 10^{-7}}{r} Nm$$

To show that the wires attract, let's calculate the forces on each wire due to the other:

$$\vec{F}_{AB} = I_B \vec{l}_B \times \vec{B}_A$$

$$\vec{F}_{AB} = -\hat{k} \times -\hat{\jmath}$$

$$\vec{F}_{AB} = -\hat{\imath}$$

The force on wire B from wire A is to the left.

$$\vec{F}_{BA} = I_B \vec{l}_B \times \vec{B}_A$$

$$\vec{F}_{BA} = -\hat{k} \times \hat{\jmath}$$

$$\vec{F}_{BA} = \hat{\imath}$$

The force on wire B from wire A is to the right.

Thus, we can see that the wires attract.

18. For two vectors $\vec{A}$ and $\vec{B}$, show that $\text{proj}_{\mathbf{B}}^{\mathbf{A}} \times \vec{A}$ is 0.

$$\text{proj}_{\mathbf{B}}^{\mathbf{A}} \times \vec{A}$$

$$\frac{\vec{A} \cdot \vec{B}}{|\vec{B}|^2} \vec{B} \times \vec{A}$$

$$\frac{\vec{A} \cdot \vec{B}}{|\vec{B}|^2} \vec{B} \times \vec{A}$$

We do know that $\frac{\vec{A} \cdot \vec{B}}{|\vec{B}|^2}$ is a scalar, and hence we can rearrange the above equation as follows:

$$(\frac{\vec{A} \cdot \vec{B}}{|\vec{B}|^2}) \vec{B} \times \vec{A}$$

For this to be the case, $\vec{A}$ & $\vec{B}$ should be orthogonal. The question has an **ERROR**.

It was meant to be $\text{proj}_{\mathbf{B}}^{\mathbf{A}} \times \vec{B}$ is 0: in that case,

$$\text{proj}_{\mathbf{B}}^{\mathbf{A}} \times \vec{B}$$

$$\frac{\vec{A}\cdot\vec{B}}{|\vec{B}|^2}\vec{B}\times\vec{B}$$

$$(\frac{\vec{A}\cdot\vec{B}}{|\vec{B}|^2})\vec{B}\times\vec{B}$$

$$(\frac{\vec{A}\cdot\vec{B}}{|\vec{B}|^2})(0)$$

$$0$$

19. A particle of mass $m = 4m_p$ is released into a uniform magnetic field of 1.5×10^{-5}T with a speed of 1.673×10^{7}m/s. Up on entering the field, the particle makes an angle of 30^0 with the field. ($m_p = 1.673 \times 10^{-27}$kg)

- What is the expected trajectory of the particle?
  The expected trajectory of the charged particle is a helix.
- What is the radius of the trajectory of the particle?

$$Bqv\sin\theta = \frac{mv^2}{r}$$

$$r = \frac{mv}{Bq\sin\theta}$$

$$r = \frac{4\times1.673\times10^{-27}kg\times1.673\times10^{7}m/s}{1.5\times10^{-5}Tq\sin30^0}$$

$$r = \frac{4\times1.673\times10^{-27}kg\times1.673\times10^{7}m/s}{1.5\times10^{-5}Tq\sin30^0}$$

$$r = \frac{8\times1.673^2\times10^{-15}Cm}{1.5q}$$

$$r = \frac{3.36\times10^{-14}Cm}{q}$$

Extra credit problems

20. Show that the magnetic field of a current carrying wire is given by $B = \frac{\mu_0 I}{2\pi a}$, where a is the radial distance from the wire.

As we have seen in class, we can use Ampere's Law to calculate the magnetic field due to a current carrying wire.

$$\oint \vec{B}\cdot d\vec{S} = \mu_0 I$$

Here, our Amperian loop is a circle, thus S is the circumference:

$$B(2\pi r) = \mu_0 I$$

$$B = \frac{\mu_0 I}{2\pi r} \text{ such that } r \text{ is the radial distance away from the wire}$$