PRACTICE MCQs

CLASS 12 PHYSICS (TERM - I)

MOVING CHARGES AND MAGNETISM

BY

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learning simplified

Question 1:
The force on the charged particle due to electric and magnetic fields is called ______.
(a) Lorentz force
(b) Ampere force
(c) Electromotive force
(d) Frictional force

Answer: (a) Lorentz force

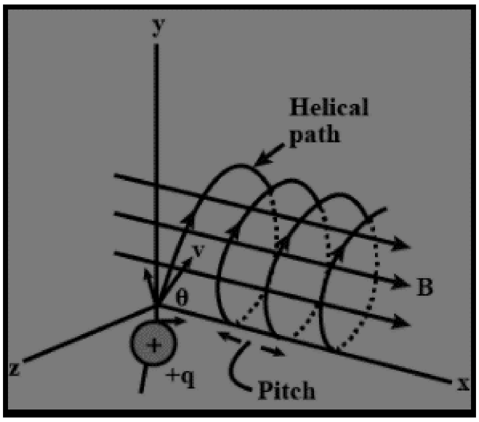
Question 2:
What will be the path of a charged particle moving along the direction of a uniform magnetic field?
(a) Circular
(b) Ellipse
(c) Straight line
(d) Helix

Answer: (c) Straight line
The path of a charged particle will be a straight-line path as no force acts on the particle.

Question 3:
Two charged particles traverse identical helical paths in a completely opposite sense in a uniform magnetic field $B = B_0k$.
(a) They have equal z-components of momenta.
(b) They must have equal charges.
(c) They necessarily represent a particle- antiparticle pair.
(d) The charge to mass ratio satisfies: $(e/m)_1+(e/m)_2= 0$

Answer: (d) The charge to mass ratio satisfies: $(e/m)_1+(e/m)_2 = 0$
In this case if the particle is thrown in x-y plane refer figure at some angle θ with velocity v, then we have to resolve the velocity of the particle in rectangular components, such that one component is along the field (v cos θ) and other one is perpendicular to the field (v sin θ). We find that the particle moves with constant velocity v cos θ along the field. The distance covered by the particle along the magnetic field is called pitch.

The pitch of the helix, (i.e., linear distance travelled in one rotation) will be given by
p=T(v cos θ)=2p (m/qB) (v cos θ)
For given pitch p correspond to charge particle, we have
(q/m) = (2πv cos θ)/(qB) = constant
Here in this case, charged particles traverse identical helical paths in a completely opposite sense in a uniform magnetic field B, LHS for two particles should be same and of opposite sign.
Therefore, $(e/m)_1+(e/m)_2 = 0$



Question 4:
An electron is projected with uniform velocity along the axis of a current carrying long solenoid. Which of the following is true?
(a) The electron will be accelerated along the axis.
(b) The electron path will be circular about the axis.
(c) The electron will experience a force at 45° to the axis and hence execute a helical path.
(d) The electron will continue to move with uniform velocity along the axis of the solenoid.

Answer: (d) The electron will continue to move with uniform velocity along the axis of the solenoid.
F = -evB sin 180° = 0 (i.e. 0= 0°or 180° in both cases F = 0). The electron will continue to move with uniform velocity or will go undeflected along the axis of the solenoid.

Question 5:

The maximum current that can be measured by a galvanometer of resistance 40 Ω is 10 mA. It is converted into voltmeter that can read upto 50 V. The resistance to be connected in the series with the galvanometer is

(a) 2010 Ω
(b) 4050 Ω
(c) 5040 Ω
(d) 4960 Ω

Answer: (d) 4960 Ω

R = (V/Ig) – G
= (50)/ (10 x 10^{-3}) - 40
= 4960 Ω

Question 6:

Galvanometer cannot as such be used as an ammeter to measure the value of the current in a given circuit

(A) The galvanometer gives full scale deflection for a small current.
(B) Galvanometer has a large resistance
(C) Galvanometer can give inaccurate values

(a) (A) and (B)
(b) (A) and (C)
(c) (B) and (C)
(d) (A), (B) and (C)

Answer: (b) (A) and (C)

Galvanometer is a very sensitive device; it gives a full-scale deflection for current of the order of micro ampere. Also, for measuring current the galvanometer has to be connected in series, and as it has a large resistance, this will change the value of the current in the circuit. To overcome these difficulties, one attaches a small resistance called shunt resistance in parallel with the galvanometer coil

Question 7:

The force between two parallel current carrying conductors separated by a distance x is F. If the current in each conductor is doubled and the distance between them is halved, then the force between them becomes.

(a) F
(b) 2F

(c) 4F
(d) 8F

Answer: (d) 8F

Let, two parallel wires having current I_1 and I_2
Distance between them is x
Force between them is F
length of two wires is L
Force between wires is
$F = (I_1 I_2 L)/2x)$
F is directly proportional to product of currents
F is inversely proportional to x
So, if we double the currents F will become 4 times
And if we halved the x, F will become 2 times
if we combine F become 8 times

Question 8:

A short bar magnet has a magnetic moment of 0. 65 J T^{-1}, then the magnitude and direction of the magnetic field produced by the magnet at a distance 8 cm from the centre of magnet on the axis is
(a) 2.5×10^{-4} T, along NS direction
(b) 2.5×10^{-4} T along SN direction
(c) 4.5×10^{-4} T, along NS direction
(d) $4.5 \times 10_{-4}$ T, along SN direction

Answer: (b) 2.5×10^{-4} T along SN direction

$M=0,65JT^{-1}$, d=8cm=0.08m
The field produced by a magnet at axial point is given by
$B=(\mu_0 2M)/ (4 \pi d^3)$
$= (2 \times 0.65)/ (0.08)^3 \times 10^{-7}$
$=2.5 \times 10^{-4}$ T along SN.

Question 9:

Which among the following options represents Biot-Savart's Law?
(a) $d\vec{B} = (\mu_0/4\pi)\, I\, (d\vec{l} \times \vec{r})/(r)$
(b) $d\vec{B} = (\mu_0/4\pi)\, I(d\vec{l} \times \vec{r})/(r^3)$
(c) $d\vec{B} = (\mu_0/4\pi)\, I\, (d\vec{l} \times \hat{r})/(r^3)$
(d) $d\vec{B} = (\mu_0/4\pi)\, I\, (d\vec{l} \times \vec{r})/(r^4)$

Answer: (b) $d\vec{B} = (\mu_0/4\pi)\, I\, (d\vec{l} \times \vec{r})/(r^3)$

If unit current is flowing through the conductor, then Biot-Savart's law is represented as
$d\vec{B} = (\mu_0/4\pi)\, I\, (d\vec{l} \times \vec{r})/(r^3)$

Question 10:
State which of the following statements are true:
Statement 1: The principle of superposition applies both on electrostatic field and magnetic field.
Statement 2: The Coulomb's law applied to electrostatic field and the Biot-Savart law applied magnetic field depend inversely on the square of distance from the source to the point of interest.
(a) both the statements are true
(b) both the statements are false
(c) statement 1 is true and statement 2 is false
(d) Statement 2 is true and statement 1 is false

Answer: (a) both the statements are true
Both the fields obey inverse square law; hence both are of long range. The electrostatic field is linearly related with the source of charge and magnetic field is linearly related with source of magnetic field i.e. $Id\vec{l}$, hence both the field obey superposition principle.

Question 11:
An electron is projected along the axis of a circular conductor carrying the same current. Electron will experience
(a) a force along the axis.
(б) a force perpendicular to the axis.
(c) a force at an angle of 4° with axis.
(d) no force experienced.

Answer: (d) no force experienced.
Since electron is moving parallel to direction of magnetic field of the conductor
Force (F) = qvB sin 0 = 0

Question 12:
For an open surface S bounded by a loop C the integral value of the tangential component of the magnetic field tends to μ_o times the total current passing through the surface, i.e., $\oint \mathbf{B}.\, d\vec{l} = \mu_o I$. This statement is termed as ____.
(a) Ampere's circuital law

(b) Gauss law
(c) Right hand thumb rule
(d) Coulomb's law

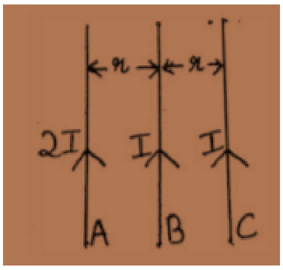
Answer: (a) Ampere's Circuital Law
Ampere's circuital law states that line integral of magnetic field forming a closed loop around the current(i) carrying wire, in the plane normal to the current, is equal to the μo times the net current passing through the close loop.

Question 13:
The current sensitivity of a galvanometer increases by 20%. If its resistance also increases by 25%, the voltage sensitivity will
(i) decreased by 1%
(ii) increased by 5%
(iii) increased by 10%
(iv) decreased by 4%

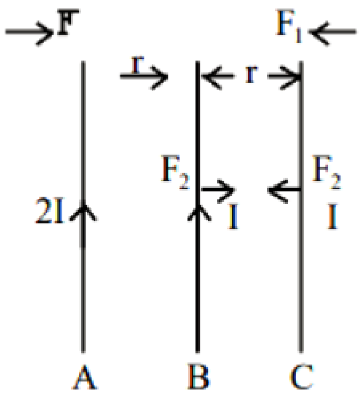
Answer: (d) decreased by 4%
Given,
$I_g' = I_g + (20/100)\ I_g$
$= (120)\ I_g$
$=1.2\ I_g$
R' = R+(25/100) R
= (125/100) R
=1.25 R
To find V_g'
$V_g' = (I_g'/R')$
$= ((1.2)\ I_g)/\ (1.25\ R)$
= (120/125) Vg
= (25/25) Vg
% change = (Vg'-Vg)/(Vg) x 100
= (24/25 Vg-Vg)/(Vg) x 100
= (24-25)/ (25) x (100)
= (-1/25) x 100
= 4%

Question 14:
Three infinitely long parallel straight current carrying wires A, B and C are kept at equal distance from each other as shown in the figure. The wire C experiences net force F. The net force on wire C, when the current in

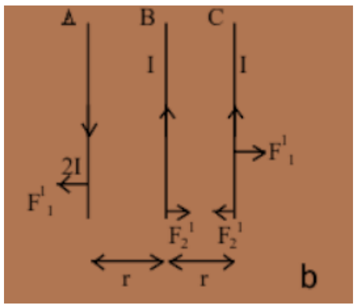
wire A is reversed will be
(a) Zero
(b) F/2
(c) F
(d) 2F



Answer: (a) Zero



Let F_1 is force per unit, length between A & C
i.e. $F_1 = (\mu_0/2\pi)\ (2I \times I)/(2r)$
and F_2 is force per unit, length between B & C
$F_2 = (\mu_0/2\pi)\ (I \times I)/(r)$
Now net force on 'C' is per unit length $F_1 + F_2 = (\mu_0/2\pi)\ (I_2/r)\ (1+1)$
$= (2\mu_0/2\pi)\ (I^2/r) = F$ (given)
Now Fig b



$F_1' =$ Repulsive force between A & C
$= (\mu_0/2\pi)\ (2I^2)/(2r)$
$F_2' = F_2 =$ A reactive force between B & C
Therefore, Net force on 'C' $F_1' - F_2' = 0$
$F_1' = F_2' = (\mu_0/2\pi)\ (2I^2)/(2r)$
Therefore, Net Force on 'C' is zero.

Question 15:
Match the following:

i) magnitude of the field B inside a long solenoid	1) IAB
ii) Magnitude of the field B for a toroid	2) $\mu_0 nI$
iii) Magnitude of the torque on a rectangular current loop in a uniform magnetic field	3) $(\mu_0 NI)/(2\pi r)$

(a) i-2, ii-3, iii-1
(b) i-3, ii-1, iii-2
(c) i-1, ii-3, iii-2
(d) i-2, ii-1, iii-3

Answer: (a) i-2, ii-3, iii-1

Question 16:
What is the ratio of magnetic momentum of a particle to its angular momentum known as?
(a) Gyromagnetic ratio
(b) Pseudomagnetic ratio
(c) Momentum ratio
(d) Paramagnetic ratio

Answer: (a) Gyromagnetic ratio
The gyromagnetic ratio, often denoted by the symbol γ (gamma) is the ratio of the magnetic momentum in a particle to its angular momentum. The SI unit is the radian per second per tesla ($rads^{-1}T^{-1}$).

Question 17:
A current carrying loop is placed in a uniform magnetic field. The torque acting on it does not depend upon
(a) Area of loop
(b) number of turns in loop
(c) shape of loop
(d) strength of current and magnetic field

Answer: (c) shape of loop

The torque acting on a current carrying loop kept in a uniform magnetic field of induction B is given by

$\tau = nIAB \sin\theta$

It depends upon n, I, A, B and θ. But it does not depend upon the shape of the loop (rectangular, circular, triangular, etc.)

Question 18:

Two wires of same length are shaped into a square and a circle if they carry same current, ratio of magnetic moment is:

(a) 2: π

(b) π: 2

(c) 4: π

(d) π: 4

Answer: (c) 4: π

Magnetic moment of a loop is given by $p_m = IA$ where, I= current through the loop

A= area of loop

Perimeter of the square should be equal to the circumference of the circle, since wires have the same length.

Therefore, $4a = 2\pi r$

Or $a = (\pi r/2)$ (1)

Consider fig (1)

In figure (i), magnetic moment of square loop is given by

$p_{ml} = I (A_1)$

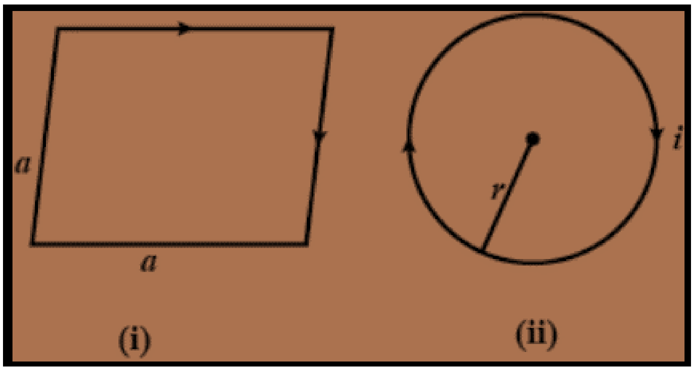
Or $p_{ml} = (I \pi^2 r^2)/ (4)$ (using equation (1) (Equation 2)

In Fig. (ii), magnetic moment of circular loop is given by

$p_{m2} = I (A_2)$

$p_{m2} = I (\pi r^2)$ (Equation 3)

$(p_{m1}/p_{m2}) = (\pi/4)$



Question 19:
What is the value of the resistance of shunt resistance?
(a) Very high value of resistance
(b) Very low value of resistance
(c) Infinite resistance
(d) Zero resistance

Answer: (b) Very low value of resistance
A resistor having a very low value of resistance such type of resistor is called shunt resistance. The shunt resistor is mainly made of the material having the low-temperature coefficient of resistance. It is connected in parallel with the ammeter whose range is to be extended. It is also connected in series with the load whose current is to be measured.

Assertion Reasoning Based Questions

Given below are two statements labelled as Assertion (A) and Reason (R).
Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false and R is also false

Question 20:
Assertion (A): Free electrons always keep on moving in a conductor even then no magnetic force act on them in magnetic field unless a current is passed through it.
Reason (R): The average velocity of free electron is zero.

Answer: (b) Both A and R are true but R is not the correct explanation of A.
In the absence of the electric current, the force electrons in a conductor are in a state of random motion, like molecule in a gas. Their average velocity is zero. i.e., they do not have any net velocity in a direction. As a result, there is no net magnetic force on the free electrons in the magnetic field. On passing the current, the free electrons acquire drift velocity in a definite direction, hence magnetic force acts on them, unless the field has no perpendicular component.

Question 21:
Assertion (A): A phosphor bronze strip is used in a moving coil galvanometer.
Reason (R): Phosphor bronze strip has the maximum value of torsional constant k.

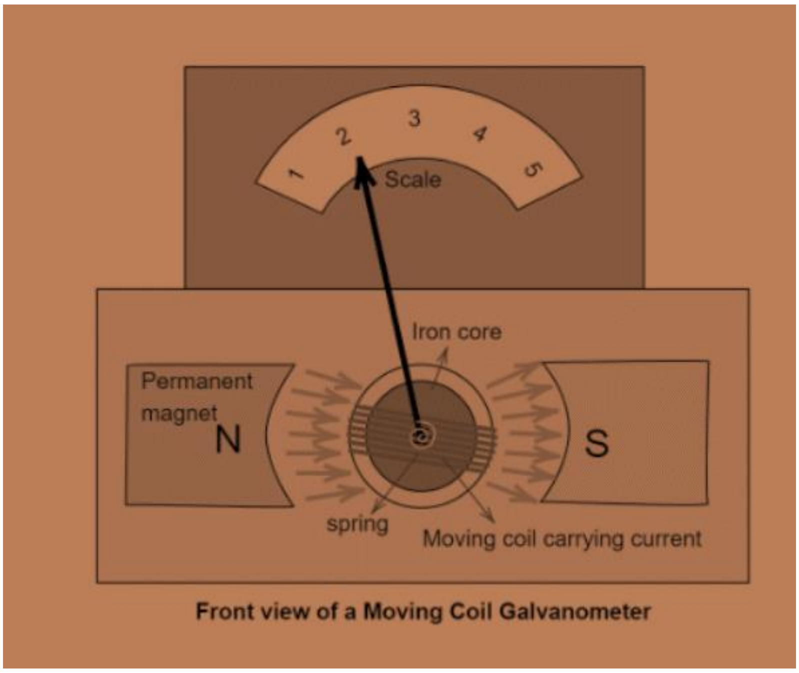
Answer: (c) A is true but R is false
Phosphor bronze is used as it does not oxidise easily, has low torsional constant and is non-magnetic.

Question 22:
Assertion (A): The torque acting on square and circular current carrying coils having equal areas, placed in uniform magnetic field, will be same.
Reason (R): Torque acting on a current carrying coil placed in uniform magnetic field does not depend on the shape of the coil, if the areas of the coils are same.

Answer: (a) Both A and R are true and R is the correct explanation of A.
The torque τ on a current-carrying loop of any shape in a uniform magnetic field is $\tau = NIAB \sin\theta$,
where N is the number of turns, I is the current, A is the area of the loop, B is the magnetic field strength, and θ is the angle between the perpendicular to the loop and the magnetic field.
If the square and rectangle shaped coils have the same cross-sectional area and number of turns, the torque will be the same. The resultant torque is not at all dependent on the shape of the coil rather the area of its single turn.

Case Study Based Questions

Question 23:
The galvanometer is a device used to detect the current flowing in a circuit or a small potential difference applied to it. It consists of a coil with many turns, free to rotate about a fixed axis, in a uniform radial magnetic field formed by using concave pole pieces of a magnet. When a current flows through the coil, a torque act on it.



1. What is the principle of moving coil galvanometer?
(a) Torque acting on a current carrying coil placed in a uniform magnetic field.
(b) Torque acting on a current carrying coil placed in a non-uniform magnetic field.
(c) Potential difference developed in the current carrying coil.
(d) None of these.

2. A current-carrying rectangular coil placed in a uniform magnetic field. In which orientation will the coil rotate?
(a) In any orientation
(b) The magnetic field is parallel to the plane of the coil
(c) The magnetic field is at 450 with the plane of the coil

(d) The magnetic field is perpendicular to the plane

3. Why pole pieces are made concave in the moving coil galvanometer?
(a) to make the magnetic field radial.
(b) to make the magnetic field uniform.
(c) to make the magnetic field non-uniform.
(d) none of these.

4. What is the function of radial field in the moving coil galvanometer?
(a) to make the torque acting on the coil maximum.
(b) to make the magnetic field strong.
(c) to make the current scale linear.
(d) all the above.

5. How is a moving coil galvanometer converted into an ammeter of desired range?
(a) Connecting a shunt resistance in series.
(b) Connecting a shunt resistance in parallel.
(c) Connecting a large resistance in series.
(d) Connecting a large resistance in parallel.

Answer:

1. (a) Torque acting on a current carrying coil placed in a uniform magnetic field.
When a current carrying coil is suspended in a uniform magnetic field it is acted upon by a torque.
Under the action of this torque, the coil rotates and the deflection in the coil in a moving coil galvanometer is directly proportional to the current flowing through the coil.

2. (d) The magnetic field is perpendicular to the plane.
In order to stop the coil to tend to rotate, no force should be acting on the current carrying coil due to magnetic field, which is possible if the current carrying coil is parallel to the direction of magnetic field.
Or, the magnetic field is perpendicular to the plane of the coil.

3. (a) to make the magnetic field radial.
The pole pieces of the galvanometer are made concave so that the current-carrying coil and the magnetic field are always perpendicular to each other.

Concave magnetic pole always produces a radial magnetic field. The radial field will always be perpendicular to the conductor rotating about the axis.

4. (d) All of the Above

The radial magnetic field is applied to a moving coil galvanometer to produce a constant torque on the coil. With the help of the radial magnetic field, the angle between the plane of the coil and the magnetic field is maintained zero in all the orientation of the coil. It helps the arm of the couple and hence the torque on coil always the same in all positions. This arrangement provides linear scale to the galvanometer.

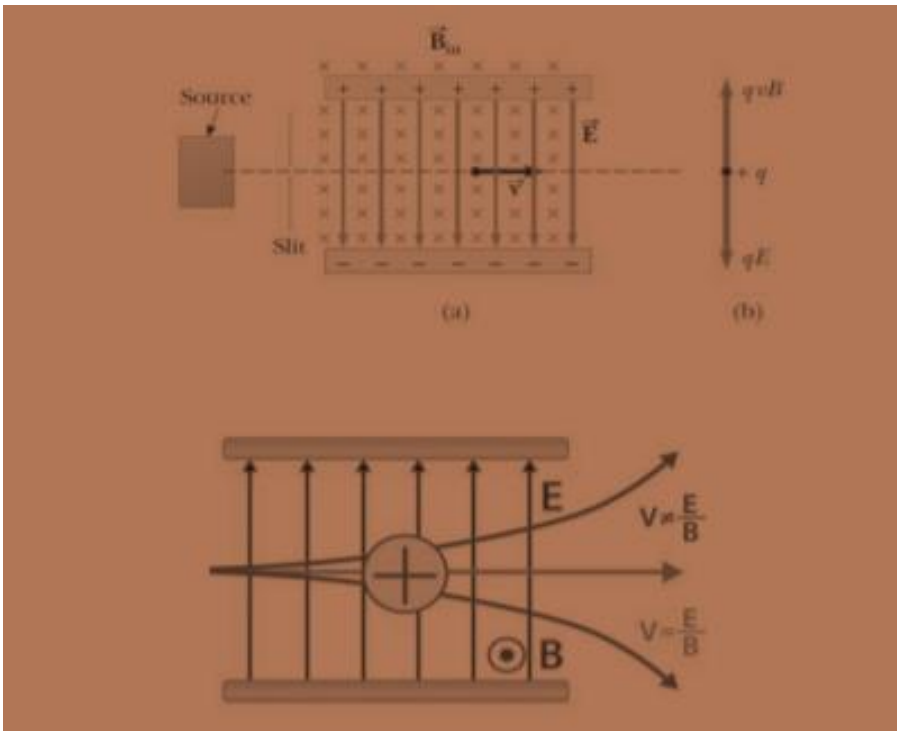
5. (b) Connecting a shunt resistance in parallel.

A moving coil galvanometer can be converted into an ammeter by connecting a low resistance called a shunt in parallel to the galvanometer.

Question 24:

A charge q moving with a velocity v in presence of both electric and magnetic fields experience a force **F =** q **[E + v x B]**. If electric and magnetic fields are perpendicular to each other and also perpendicular to the velocity of the particle, the electric and magnetic forces are in opposite directions.

If we adjust the value of electric and magnetic field such that magnitude of the two forces is equal. The total force on the charge is zero and the charge will move in the fields un deflected.



1. A charged particle goes undeflected in a region containing electric and magnetic field. It is possible that.
(a) **E|| B**, **v||E**
(b) **E** is not parallel to **B**
(c) **E || B** but **v** is not parallel to **E**
(d) Both (c) and (b)

2. Proton, neutron, alpha particle and electron enter a region of uniform magnetic field with same velocities. The magnetic field is perpendicular to the velocity. Which particle will experience maximum force?
(a) Proton
(b) Electron
(c) Alpha particle
(d) Neutron

3. A charge particle moving with a constant velocity passing through a space without any change in the velocity. Which can be true about the region?
(a) $E = 0, B = 0$
(b) $E \neq 0, B \neq 0$
(c) $E = 0, B \neq 0$
(d) $E \neq 0, B = 0$

4. A proton, a deuteron and an alpha-particle with the same KE enter a region of uniform magnetic field, moving at right angles to B. What is the ratio of the radii of their circular paths?
(a) $1: \sqrt{2}:1$
(b) $1: \sqrt{2}: \sqrt{2}$
(c) $\sqrt{2}:1:1$
(d) $2: \sqrt{2}: \sqrt{1}$

Answer:

1. (d) Both (a) and (b)
(a) The charged particle will get accelerated in the direction or opposite to the electric field **E** and will not deflected since **v** || **B**
(b) If **E**|| **B** deflection due to magnetic field can be balanced by acceleration due to electric field.
(c) **v**|| **B** => F_{mag} =0 Since **E** not parallel to **B** the particle will get deflected.
(d) **E**|| **B** and **v** not parallel to **B**⇒ the particle will get deflected.

(2) (c) Alpha Particle

Alpha particle experiences maximum force because it has the maximum charge.

(3) (b) $E \neq 0, B \neq 0$

We know that any moving charged particle will both have the electric and magnetic field.
So, when a charged particle moving with constant velocity passes through a region of space without any change in its velocity, it both have magnetic and electric field, $E \neq 0, B \neq 0$.

(4) (a) 1: √2: 1

At right angles to magnetic field, charged particles acquire circular path at which magnetic force provides necessary centripetal force to keep it moving on circular path.
i.e., $qvB=(mv^2)/(r)$
Therefore, $r=(mv)/(qB) =\sqrt{(2mE)/(q^2B^2)}$
Since, $r_p=\sqrt{(2mE)/(e^2B^2)}$,
$r_p=(\sqrt{2\times2m\times E})/(e^2B^2)$
and $r_\alpha=(\sqrt{2\times4m\times E})/((2e)^2B^2)$
Therefore, $r_p: r_d: r_\alpha=1: \sqrt{2}:1$

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