DPP - Daily Practice Problems

Name : | Date :

Start Time : | End Time :

PHYSICS 40

SYLLABUS : MAGNETIC EFFECTS OF CURRENT-2 :
(Motion of charge particle in a magnetic field, force between current carrying wires.)

Max. Marks : 104 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 26 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.18) : There are 18 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

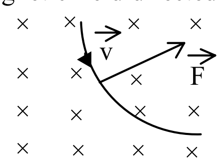
Q.1 A proton, a deutron and an α-particle are accelerated through same potential difference and then they enter a normal uniform magnetic field. The ratio of their kinetic energies will be-
(a) 2 : 1 : 3 (b) 1 : 1 : 2 (c) 1 : 1 : 1 (d) 1 : 2 : 4

Q.2 A proton of energy 8eV is moving in a circular path in a uniform magnetic field. The energy of an α-particle moving in the same magnetic field and along the same path will be-
(a) 4eV (b) 2eV
(c) 8eV (d) 6eV

Q.3 An electron is revolving in a circular path of radius 2×10^{-10} m with a speed of 3×10^{6} m/s. The magnetic field at the centre of circular path will be-
(a) 1.2 T (b) 2.4 T (c) 0 (d) 3.6 T

Q.4 An α particle travels at an angle of 30º to a magnetic field 0.8 T with a velocity of 10^5 m/s. The magnitude of force will be-
(a) 1.28×10^{-14} N (b) $(1.28)\sqrt{3} \times10^{-4}$ N
(c) 1.28×10^{-4} N (d) $(12.8)\sqrt{3} \times10^{-4}$ N

Q.5 A beam of protons is moving horizontally towards you. As it approaches, it passes through a magnetic field directed downward. The beam deflects-
(a) to your left side
(b) to your right side
(c) does not deflect
(d) nothing can be said



RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

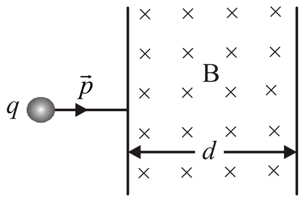
Q.6 If a particle moves in a circular path in clockwise direction after entering into a downward vertical magnetic field. The charge on the particle is-
(a) positive (b) negative
(c) nothing can be said (d) neutral

Q.7 In the example above, after how much time, particle comes to the starting point for the first time. (mass of particle = m)
(a) $\frac{2\pi m}{3qB}$
(b) $\frac{2\pi m}{qB}$
(c) Never
(d) It will leave the circular path before coming to the starting point

Q.8 A current of 2.0 amp is flowing through a wire of length 50 cm. If this wire be placed at an angle of 60º with the direction of a uniform magnetic field of 5.0×10^{-4} N/Am the force on the wire will be-
(a) 4.33×10^{-4} N (b) 2.50×10^{-4} N
(c) 5.0×10^{-4} N (d) 2.33×10^{-4} N

Q.9 A particle of mass m and charge q moves with a constant velocity v along the positive x direction. It enters a region containing a uniform magnetic field B directed along the negative z direction, extending from $x = a$ to $x = b$. The minimum value of v required so that the particle can just enter the region $x < b$ is
(a) $qb\,B/m$ (b) $q(b - a)\,B/m$
(c) $qa\,B/m$ (d) $q(b + a)\,B/2m$

Q.10 A particle with charge q, moving with a momentum p, enters a uniform magnetic field normally. The magnetic field has magnitude B and is confined to a region of width d, where $d < \frac{p}{Bq}$, The particle is deflected by an angle θ in crossing the field. Then

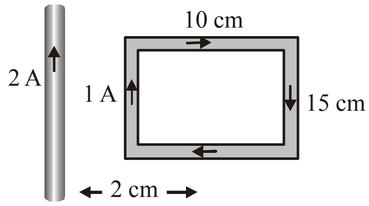


(a) $\sin\theta = \frac{Bqd}{p}$
(b) $\sin\theta = \frac{p}{Bqd}$
(c) $\sin\theta = \frac{Bp}{qd}$
(d) $\sin\theta = \frac{pd}{Bq}$

Q.11 An α particle is moving in a magnetic field of $(3\hat{i} + 2\hat{j})$ tesla with a velocity of $5\times10^5\,\hat{i}$ m/s. The magnetic force acting on the particle will be-
(a) 3.2×10^{-13} dyne (b) 3.2×10^{13} N
(c) 0 (d) 3.2×10^{-13} N

Q.12 If an α-particle moving with velocity 'v' enters perpendicular to a magnetic field then the magnetic force acting on it will be-
(a) evB (b) 2evB (c) 0 (d) 4evB

Q.13 What is the net force on the square coil ?



(a) 25×10^{-7} N towards wire
(b) 25×10^{-7} N away from wire
(c) 35×10^{-7} N towards wire
(d) 35×10^{-7} N away from wire

Q.14 A proton is to circulate the earth along the equator with a speed of 1.0×10^7 m/s. The minimum magnetic field which should be created at the equator for this purpose.
(The mass of proton = 1.7×10^{-27} kg and radius of earth = 6.37×10^6 m.) will be (in Wb/m^2)
(a) 1.6×10^{-19} (b) 1.67×10^{-8}
(c) 1.0×10^{-7} (d) 2×10^{-7}

Q.15 An α-particle is describing a circle of radius 0.45 m in a field of magnetic induction 1.2 weber/m^2. The potential difference required to accelerate the particle, (The mass of α-particle is 6.8×10^{-27} kg and its charge is 3.2×10^{-19} coulomb.) will be —
(a) 6×10^6 V (b) 2.3×10^{-12} V
(c) 7×10^6 V (d) 3.2×10^{-12} V

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ

Space for Rough Work

Q.16 An electron beam passes through a magnitic field of 2×10^{-3} weber/m^2 and an electric field of 1.0×10^4 volt/m both acting simultaneously. If the electric field is removed, what will be the radius of the electron path ?
(a) 1.43 cm. (b) 0.43 cm (c) 2.43 cm. (d) 3.43 cm.

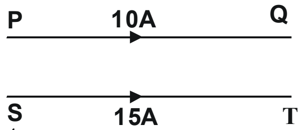
Q.17 A straight horizontal copper wire carries a current i = 30 A. The linear mass density of the wire is 45 g/m. What is the magnitude of the magnetic field needed to balance its weight?
(a) 147 G (b) 441 G (c) 14.7 G (d) 0 G

Q.18 A 1m long conducting wire is lying at right angles to the magnetic field. A force of 1 kg. wt is acting on it in a magnetic field of 0.98 tesla. The current flowing in it will be-
(a) 100 A (b) 10 A (c) 1 A (d) 0

DIRECTIONS (Q.19-Q.20) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :
(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.19 In the fig the two parallel wires PQ and ST are at 30 cm apart. The currents flowing in the wires are according to fig. The force acting over a length of 5m of the wires is-



(1) 5×10^{-4} N (2) attraction
(3) 5×10^{-8} N (4) repulsion

Q.20 A beam of protons enters a uniform magnetic field of 0.3 tesla with a velocity of 4×10^5 m/s at an angle of 60º to the field. Then,
(Mass of the proton = 1.7×10^{-27} kg.)
(1) the radius of the helical path is 1.226×10^{-2} m
(2) the pitch of the helix is 4.45×10^{-2} m
(3) the radius of the helical path is 1.226×10^{-3} m
(4) the pitch of the helix is 4.45×10^{-4} m

DIRECTIONS (Q.21-Q.23) : Read the passage given below and answer the questions that follows :

A charge particles q enters in a magnetic field $\vec{B} = y\hat{i} + x\hat{j}$ with the velocity $\vec{v} = x\hat{i} + y\hat{j}$. Neglect any force other than magnetic force. Now answer the following question.

Q.21 When particle arrives at any point P (2, 2) then force acting on it, will be –
(a) Zero (b) $4\sqrt{2}q$ (c) 8q (d) $2\sqrt{2}q$

Q.22 Magnetic force F acting on charge is proportional to –
(a) $F \propto (x^2 - y^2)$
(b) $F \propto (x^2 + y^2)$
(c) $F \propto \sqrt{x^2 + y^2}$
(d) F does not depend on x or y co-ordinate

Q.23 Which of the following is true for the direction of magnetic force ?
(a) if x > y then force works along (–z) direction
(b) if x < y then force works along (+z) direction
(c) if x > y then force works along (+z) direction
(d) None of these

DIRECTIONS (Qs. 24-Q.26) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement -1 is False, Statement-2 is True.
(d) Statement -1 is True, Statement-2 is False.

Q.24 **Statement -1 :** If two long wires, hanging freely are connected to a battery in series, they come closer to each other.
Statement -2 : Force of repulsion acts between the two wires carrying current.

RESPONSE GRID					
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	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ	

Space for Rough Work

Q.25 Statement - 1 : For a charged particle to pass through a uniform electro-magnetic field without change in velocity, its velocity vector must be perpendicular to the magnetic field.

Statement - 2 : Net Lorentz force on the particle is given by $\vec{F} = q[\vec{E} + \vec{v} \times \vec{B}]$.

Q.26 Statement - 1 : If an electron is not deflected while passing through a certain region of space, then only possibility is that there is no magnetic region.

Statement - 2 : Magnetic force is directly proportional to the magnetic field applied.

RESPONSE GRID	25. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 40 - PHYSICS			
Total Questions	26	Total Marks	104
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	26	Qualifying Score	46
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS — PHYSICS SOLUTIONS 40

(1) (b) $E_{kp} = eV$, $\therefore E_k = qV$,
$\therefore E_k \propto q$, $\therefore V$ = constant
$E_{kp} : E_{kd} : E_{ka} :: 1 : 1 : 2$.

(2) (c) $E_K = \dfrac{q^2r^2B^2}{2m}$

$\therefore E_k \propto \dfrac{q^2}{m} = \dfrac{q_a^2}{m_p^2} \times \dfrac{m_p}{E_{k_p}}$

$= \dfrac{4}{1} \times \dfrac{1}{4} = E_{K_a} = 8eV.$

(3) (a) $B = \dfrac{KVe}{r^2} = \dfrac{10^{-7} \times 3 \times 1.6^6 \times 10^{-19}}{(2 \times 10^{-10})^2} = 1.2$ Tesla.

(4) (a) $F = qvB \sin\theta$

$= 2 \times 1.6 \times 10^{-19} \times 10^5 \times 0.8 \times \left(\dfrac{1}{2}\right)$

$= 1.28 \times 10^{-14}$ N [$\because$ charge on α particle = 2e]

(5) (b) The direction of $\vec{F}$ is along $(\vec{V} \times \vec{B})$ which is towards the right. Thus the beam deflects to your right side.

(6) (b) The particle is moving clockwise which shows that force on the particle is opposite to given by right hand palm rule of fleming left hand rule. These two laws are used for positive charge. Here since laws are disobeyed, we can say that charge is negative.

(7) (b) The point lies at the circumference hence it will come back after a time period T

$T = \dfrac{2\pi m}{qB}$

(8) (a) The magnetic force on a current carrying wire of length L, placed in a magnetic field B at an angleθ with the field is given by
$F = i\,\ell\, B\sin\theta$.
Here $B = 5.0 \times 10^{-4}$ N/A.m. $i = 2.0$ A,
$\ell = 50$ cm $= 0.50$ m,
$\theta = 60°$
$F = 2.0 \times 0.50 \times (5.0 \times 10^{-4}) \times \sin 60°$
$= 4.33 \times 10^{-4}$ N
According to the flemings left - hand rule, this force will act perpendicular to both the wire and the magnetic field.

(9) (a, c) $r \propto \dfrac{\sqrt{m}}{q} \Rightarrow r_H : r_{He} : r_o = \dfrac{\sqrt{1}}{1} : \dfrac{\sqrt{4}}{1} : \dfrac{\sqrt{16}}{2} = 1 : 2 : 2$

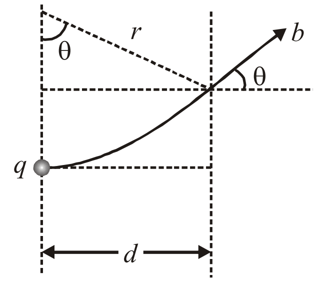
Radius is smallest for H^+, so it is deflected most.

(10) (b) In the figure, the z-axis points out of the paper, and the magnetic field is directed into the paper, existing in the region between PQ and RS. The particle moves in a circular path of radius r in the magnetic field. It can just enter the region $x > b$ for $r \ge (b - a)$

Now $r = \dfrac{mv}{qB} \ge (b - a)$

or $v \ge \dfrac{q(b-a)B}{m} \Rightarrow v_{min} = \dfrac{q(b-a)B}{m}$

(11) (a) From figure it is clear that



$\sin\theta = \dfrac{d}{r}$ also $r = \dfrac{p}{qB}$

$\therefore \sin\theta = \dfrac{Bqd}{p}$

(12) (a) For on wire Q due to wire P is

$F_P = 10^{-7} \times \dfrac{2 \times 30 \times 10}{0.1} \times 0.1 = 6 \times 10^{-5}$ N (Towards left)

Force on wire Q due to wire R is

$F_R = 10^{-7} \times \dfrac{2 \times 20 \times 10}{0.02} \times 0.1 = 20 \times 10^{-5}$ (Towards right)

Hence $F_{net} = F_R - F_P = 14 \times 10^{-5}$N $= 14 \times 10^{-4}$ N (Towards right)

(13) (d) $\vec{F} = q(\vec{v} \times \vec{B})$

$$\vec{v} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 2 & 0 \\ 5 \times 10^5 & 0 & 0 \end{vmatrix} = \hat{k}\,(-10 \times 10^5) = (-\hat{k}\ 10^6)$$

$q = 2e = 2 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-19}$ Coulomb

$\vec{F} = 3.2 \times 10^{-19} (-\hat{k} \times 10^6)$

$\Rightarrow \vec{F} = -3.2 \times 10^{-13}\,\hat{k}$.

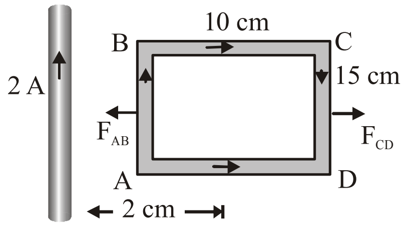
$\therefore |F| = 3.2 \times 10^{-13}$ Coulomb.

(14) (b)

$\therefore F = q(\vec{v} \times \vec{B}) = 2evB \sin 90°$

or $F = 2evB$

(15) (a) Force on side BC AND AD are equal but opposite so their net will be zero.



But $F_{AB} = 10^{-7} \times \frac{2\times2\times1}{2\times10^{-2}} \times 15\times10^{-2} = 3 \times 10^{-6}$ N

and $F_{CD} = 10^{-7} \times \frac{2\times2\times1}{(2\times10^{-2})} \times 15\times10^{-2} = 0.5 \times 10^{-6}$ N

$\Rightarrow \quad F_{net} = F_{AB} - F_{CD} = 2.5 \times 10^{-6}$ N
$= 25 \times 10^{-7}$ N, towards the wire.

(16) (b) In order to make a proton circulate the earth along the equator, the minimum magnetic field induction $\vec{B}$ should be horizontal nad perpendicular to equator. The magnetic force provides the necessary centripetal force.

i.e. $qvB = \frac{mv^2}{r}$ or $B = \frac{mv}{qr}$

Here $m = 1.7 \times 10^{-27}$ kg, $v = 1.0 \times 10^7$ m/s
$q = e = 1.6 \times 10^{-19}$ coulomb, $r = 6.37 \times 10^6$ m

$$B = \frac{1.7\times10^{-27}\times1.0\times10^{7}}{1.6\times10^{-19}\times6.37\times10^{6}} = 1.67 \times 10^{-8} \text{ weber/m}^2.$$

(17) (c) We have $F = qvB = \frac{mv^2}{r}$ or $v = \frac{qBr}{m}$

$$= \frac{3.2\times10^{-19}\times1.2\times0.45}{6.8\times10^{-27}} = 2.6 \times 10^7 \text{ m/s.}$$

The frequency of rotation $n = \frac{v}{2\pi r}$

$$= \frac{2.6\times10^{7}}{2\times3.14\times0.45} = 9.2 \times 10^6 \text{ sec}^{-1}.$$

Kinetic energy of α-particle,

$$E_K = \frac{1}{2} \times 6.8 \times 10^{-27} \times (2.6 \times 10^7)^2$$
$= 2.3 \times 10^{-12}$ joule.

$$= \frac{2.3\times10^{-12}}{1.6\times10^{-19}} \text{ eVolt} = 14 \times 10^6 \text{ eV} = 14 \text{ MeVolt.}$$

If V is accelerating potential of α-particle, then Kinetic energy = qV
14×10^6 eVolt = 2eV (since charge on α-particle = 2e)

$\therefore \quad V = \frac{14\times10^{6}}{2} = 7 \times 10^6$ Volt.

(18) (a) If electron beam passes undeflected in simultaneous electric and magnetic fields $\vec{E}$ and $\vec{B}$ velocity of beam $\vec{v}$ much be mutually perpendicular and the required speed v is given by-

$$v = \frac{E}{B} = \frac{1\times10^{4}}{2\times10^{-3}} = 5 \times 10^6 \text{ m/s.}$$

If electric field is removed, the electron traverses a circular path of radius r given by $\frac{mv^2}{r} = evB$ or $r = \frac{mv}{eB}$.

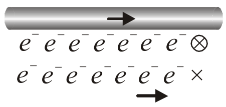
Here $m = 9.1 \times 10^{-31}$ kg, $v = 5 \times 10^6$ m/s.
$e = 1.6 \times 10^{-19}$ coul and $B = 2 \times 10^{-3}$ weber/m^2

$$\therefore \quad r = \frac{(9.1\times10^{-31})(5\times10^{6})}{(1.6\times10^{-19})(2\times10^{-3})}$$
$= 1.43 \times 10^{-2}$ m = 1.43 cm.

(19) (a) For L length or wire, to balance,
$F_{magnetic} = mg \Rightarrow ILB = mg$,
Therefore $B = mg/IL = (m/L)g/I$

$$= \frac{45\times10^{-3}\times9.8}{30} = 1.47 \times 10^{-2} \text{ tesla.}$$
= 147 Gauss.

(20) **(b)** According to Fleming's left hand rule, magnetic force on electrons will be downward.



(21) (b) $\therefore F = mg = Bi\ell$
or $1 \times 9.8 = 0.98 \times i \times 1, \Rightarrow i = 10$A.

(22) (b) When currents flow in two long, parallel wires in the same direction, the wires exert a force of attraction on each other. The magnitude of this force acting per meter length of the wires is given by

$$F = \frac{\mu_0}{2\pi}\frac{i_1 i_2}{R} = 2 \times 10^{-7} \frac{i_1 i_2}{R} \text{ N/m.}$$

Here $i_1 = 10$ A, $i_2 = 15$ A, R = 30 cm = 0.3 m

$$\therefore \quad F = 2 \times 10^{-7} \frac{10\times15}{0.3} = 1 \times 10^{-4} \text{ N/m.}$$

∴ Force on 5m length of the wire
$= 5 \times (1 \times 10^{-4}) = (5 \times 10^{-4}) = 5 \times 10^{-4}$ N (attraction).

(23) (d) The electron will pass undeviated if the electric force and magnetic force are equal and opposite. Thus
E.e. = Bev or B = E/v but E = V/d

Therefore, $B = \frac{V}{v.d.} = \frac{600}{3\times10^{-3}\times2\times10^{6}}$

$\therefore \quad B = 0.1$ Wb/m^2.
The direction of field is perpendicular to the plane of paper vertically downward.

(24) (b) The component of velocity of the beam of protons, parallel to the field direction

$= v\cos\theta = 4 \times 10^5 \times \cos 60° = 2 \times 10^5$ m/sec.

and the component of velocity of the proton beam at right angle to the direction of field

$= v\sin\theta = 4 \times 10^5 \times \sin 60° = 2\sqrt{3} \times 10^5$ m/sec.

therefore,the radius of circular path = (mv sinθ /Be)

$$\text{or } r = \frac{1.7 \times 10^{-27} \times 2\sqrt{3} \times 10^5}{0.3 \times 1.6 \times 10^{-19}} = 12.26 \times 10^{-3} \text{ metre}$$

or $r = 1.226 \times 10^{-2}$ metre.

Pitch of the Helix = v cosθ x (2πm/Be)

$$\therefore \quad \text{Pitch} = \frac{2 \times 10^5 \times 2 \times 3.14 \times 1.7 \times 10^{-27}}{0.3 \times 1.6 \times 10^{-19}}$$

$= 44.5 \times 10^{-3}$ m $= 4.45 \times 10^{-2}$ m.

(25) **(a), (26) (a), (27) (c).**

$$\vec{F} = q(\vec{v} \times \vec{B}) = q(x^2 - y^2)\hat{k}$$

(28) (c) When two long parallel wires, are connected to a battery in series. They carry currents in opposite directions, hence they repel each other.

(29) (c) No net force will act on charged particle if

$$\vec{F} = q[\vec{E} + \vec{v} \times \vec{B}] = 0$$

$\Rightarrow \vec{E} = -\vec{v} \times \vec{B} \Rightarrow$ v need not to be perpendicular to B

(30) (c) In this case we can not be sure about the absence of the magnetic field because if the electron moving parallel to the direction of magnetic field, the angle between velocity and applied magnetic field is zero (F = 0). Then also electron passes without deflection.

Also $F = evB\sin\theta \Rightarrow F \propto B$.