## DPP – 2 (Magnetism & Matter)

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Q 1. Earth's magnetic field always has a horizontal component except at or Horizontal component of earth's magnetic field remains zero at
(a) Equator
(b) Magnetic poles
(c) A latitude of $60^o$
(d) An altitude of $60^o$

Q 2. The correct relation is
(a) $B = \frac{B_H}{B_V}$
(b) $B = B_H \times B_V$
(c) $B = \sqrt{B_H^2 + B_V^2}$
(d) $B = B_H + B_V$
(Where $B_H$ = Horizontal component of earth's magnetic field, $B_V$ = Vertical component of earth's magnetic field and B = Total intensity of earth's magnetic field)

Q 3. At a certain place, the horizontal component of earth's magnetic field is $\frac{1}{\sqrt{3}}$ times of its vertical component. The angle of dip at that place is
(a) $30^0$
(b) $45^0$
(c) $75^0$
(d) $60^0$

Q 4. The earth's magnetic field at a certain place has a horizontal component 0.3 Gauss and the total strength 0.5 Gauss. The angle of dip is:
(a) $\tan^{-1}\frac{3}{4}$
(b) $\sin^{-1}\frac{3}{4}$
(c) $\tan^{-1}\frac{4}{3}$
(d) $\sin^{-1}\frac{3}{5}$

Q 5. A magnetic needle (free to rotate in any direction) will show which one of the following directions at the earth's magnetic pole
(a) Vertical
(b) No particular direction
(c) Bent at 45° to the vertical
(d) Horizontal

Q 6. A short magnet of moment 6.75 $Am^2$ produces a neutral point on its axis. If horizontal component of earth's magnetic field is $5 \times 10^{-5}\ Wb/m^2$, then the distance of the neutral point from center of magnet should be
(a) 10 cm
(b) 20 cm
(c) 30 cm
(d) 40 cm

Q 7. At a given place on earth's surface the horizontal component of earths magnetic field is $2 \times 10^{-5}$T and resultant magnetic field is $4 \times 10^{-5}$T. The angles of dip at this place is:

(a) $30^0$ (b) $60^0$
(c) $90^0$ (d) $45^0$

Q 8. The true value of angle of dip at a place is 60°, the apparent dip in a plane inclined at an angle of 30° with magnetic meridian is

(a) $\tan^{-1}\left(\frac{1}{2}\right)$ (b) $\tan^{-1}(2)$
(c) $\tan^{-1}\left(\frac{2}{3}\right)$ (d) None of these

Q 9. The true dip at a place is $30^0$. What is the apparent dip when the dip circle is turned $60^0$ out of the magnetic meridian ?

(a) $\tan^{-1}\left(\frac{1}{\sqrt{6}}\right)$ (b) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$
(c) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (d) None of these

Q 10. If a dip circle is placed in a vertical plane at an angle of $30^0$ to the magnetic meridian, the dip needle makes an angle of $45^0$ with the horizontal. The real dip at that place is?

(a) $\tan^{-1}\left(\frac{2}{3}\right)$ (b) $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$
(c) $\tan^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (d) $\tan^{-1}\left(\frac{\sqrt{3}}{\sqrt{2}}\right)$

Q 11. At a certain place a magnet makes 30 oscillations per minute. At another place where the magnetic field is double, its time period will be

(a) 4 sec (b) 2 sec
(c) $\frac{1}{2}$ sec (d) $\sqrt{2}$ sec

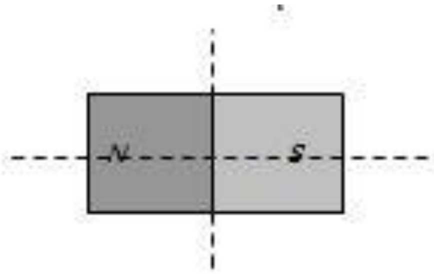
Q 12. If the strength of the magnetic field is increased by 21%, the frequency of a magnetic needle oscillating in that field:

(a) Increases by 10% (b) Decreases by 10%
(c) Increases by 11% (d) Decreases by 11%

Q 13. A magnetic needle of magnetic moment $6.7 \times 10^{-2}\ Am^2$ and moment of inertia $7.5 \times 10^{-6}\ kg\ m^2$ is performing simple harmonic oscillations in a magnetic field of 0.01T. Time taken for 10 complete oscillations is :

(a) 7.76 $s$ (b) 6.65 s
(c) 8.89 s (d) 9.98 s

Q 14. Time period for a magnet is T. If it is divided in four equal parts along its axis and perpendicular to its axis as shown then time period for each part will be




(a) $4T$ (b) $\frac{T}{4}$
(c) $\frac{T}{2}$ (d) T

Q 15. Two bar magnets of the same mass, length and breadth but magnetic moments M and 2M respectively, when jointed in same position (Similar pole in same direction), time period is 3 sec. What will be the time period when they are placed in different position (Similar pole in opposite direction) :
(a) $\sqrt{3}$ sec (b) $3\sqrt{3}$ sec
(c) 3 sec (d) 6 sec

Q 16. A dip needle in a vertical plane perpendicular to the magnetic meridian will remain-
(a) Vertical
(b) Horizontal
(c) In any direction
(d) Inclined at 45º with horizontal

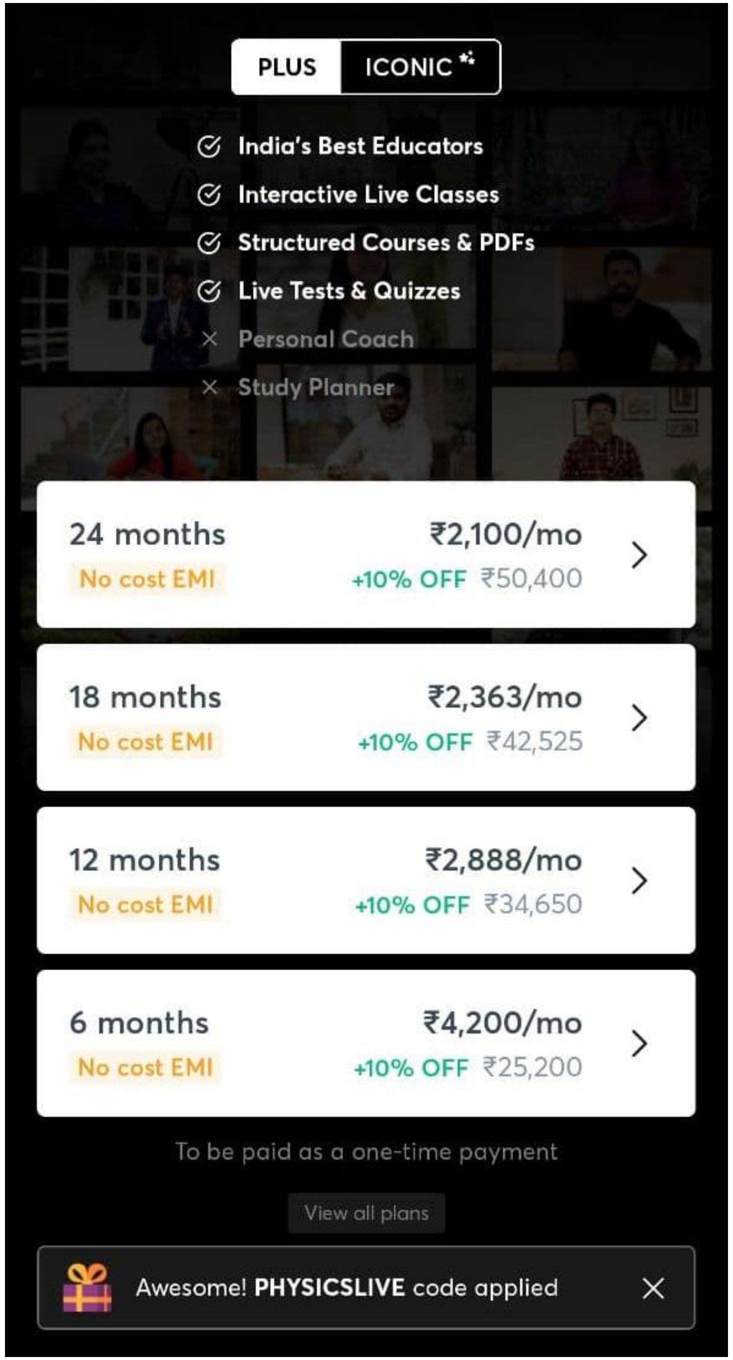
Q 17. When a magnet is placed vertical then the number of neutral point obtained in the plane of paper is-
(a) 1 (b) 2 (c) 4 (d) 3

Q 18. The magnetic needle of a tangent galvanometer is deflected at an angle 30º. The horizontal component of earth's magnetic field $0.34 \times 10^{-4}$ T is along the plane of the coil. The magnetic field of coil-
(a) $1.96 \times 10^{-4}$ T (b) $1.96 \times 10^{-5}$ T
(c) $1.96 \times 10^{4}$ T (d) $1.96 \times 10^{5}$ T



# Answer Key

| | | | | |
|---|---|---|---|---|
| **Q.1 b** | **Q.2 c** | **Q.3 d** | **Q.4 c** | **Q.5 a** |
| **Q.6 c** | **Q.7 b** | **Q.8 b** | **Q.9 c** | **Q.10 b** |
| **Q.11 d** | **Q.12 a** | **Q.13 b** | **Q.14 c** | **Q.15 b** |
| **Q.16 a** | **Q.17 a** | **Q.18 b** | | |

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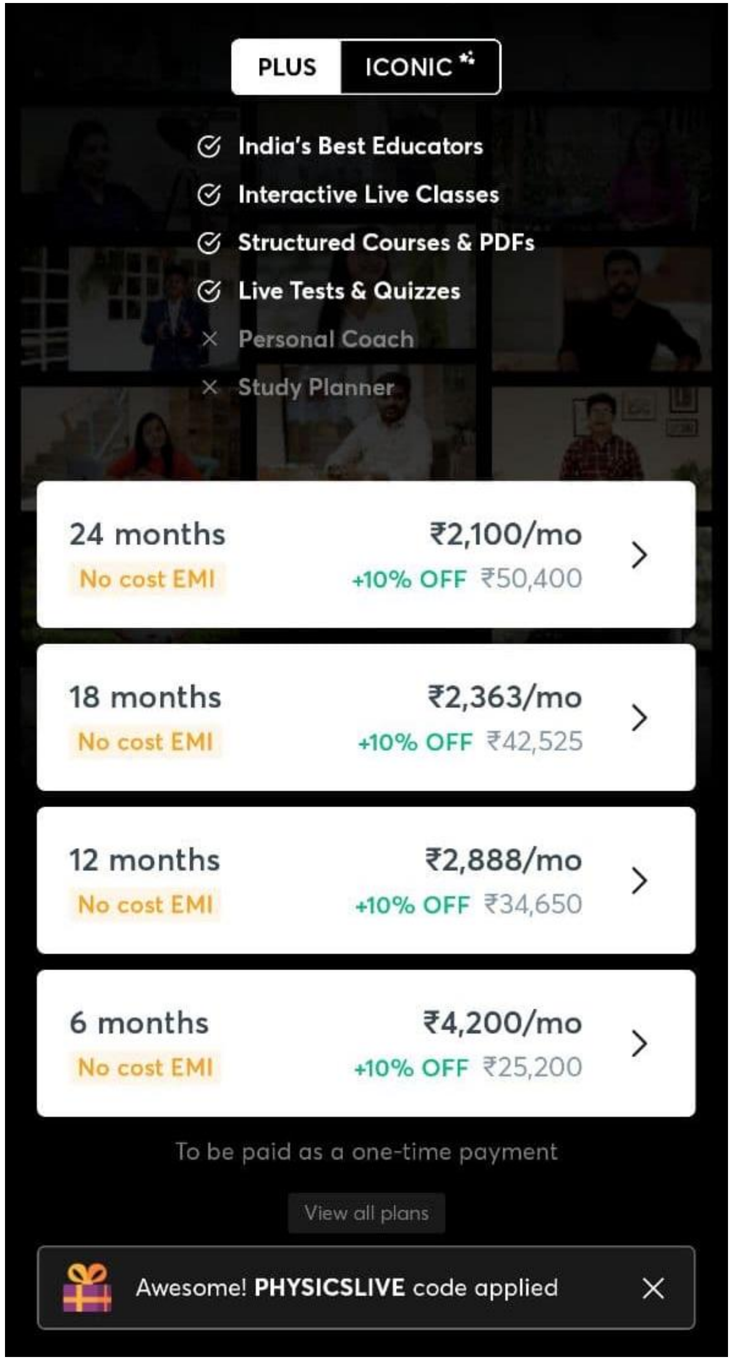


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# Written Solution

**DPP-2 :Magnetism- Earth Magnetism & Oscillations of Magnet in magnetic field**

**By Physicsaholics Team**

Solution: 1

Horizontal component of Earth's magnetic field

$B_H = B\cos\theta$ ; $\theta$ = Angle of Dip

$B\cos\theta = 0 \Rightarrow \cos\theta = 0 \Rightarrow \boxed{\theta = 90^\circ}$

so; $B_H = 0$ ; at Dip angle $= 90^\circ$

and dip angle is $90^\circ$ at Poles.



Ans. b

## Solution: 2


$$B = \sqrt{B_H^2 + B_V^2}$$ Ans.



Ans. c

# Solution: 3

let $\theta$ = Angle of dip

then; $B_H = B\cos\theta$

& $B_V = B\sin\theta$

given $B_H = \frac{1}{\sqrt{3}} B_V$

$\Rightarrow B\cos\theta = \frac{1}{\sqrt{3}} B\sin\theta$

$\tan\theta = \sqrt{3}$

$\theta = \tan^{-1}(\sqrt{3})$

$\boxed{\theta = 60^\circ}$ Ans.



Ans. d

## Solution: 4

$B_H = B\cos\theta$

$B_V = B\sin\theta$

$$\frac{B_V}{B_H} = \tan\theta$$

Now from $B^2 = B_H^2 + B_V^2$

$(0.5)^2 = (0.3)^2 + B_V^2$

$\Rightarrow B_V = 0.4$ Gauss

$\Rightarrow \tan\theta = \frac{0.4}{0.3} = \frac{4}{3}$

$$\theta = \tan^{-1}\left(\frac{4}{3}\right)$$ Ans.



Ans. c

Solution: 5

At poles magnetic field is perpendicular to the surface of earth. Hence, a compass needle will show in vertical direction at the earth's magnetic pole.



Ans. a

# Solution: 6

at Neutral Point

|magnetic field due to magnet| = |magnetic field due to Earth (Horizontal component)|

$$\frac{\mu_0}{4\pi} \times \frac{2M}{r^3} = 5 \times 10^{-5}$$

$$10^{-7} \times \frac{2 \times 6.75}{r^3} = 5 \times 10^{-5}$$

$$r^3 = \frac{2 \times 6.75}{5} \times 10^{-2}$$

$$r^3 = 2 \times 1.35 \times 10^{-2}$$

$$r^3 = 2.70 \times 10^{-2}$$

$$r^3 = 27 \times 10^{-3}$$

$$r^3 = 3^3 \times (10^{-1})^3$$

$$r = 3 \times 10^{-1}$$

$$r = 0.3\,m$$

$$r = 30\,cm$$



Ans. c

# Solution: 7

$$B_H = B\cos\theta$$

$$\cos\theta = \frac{B_H}{B}$$

$$\cos\theta = \frac{2\times10^{-5}}{4\times10^{-5}}$$

$$\cos\theta = 1/2$$

$$\theta = \cos^{-1}(1/2)$$

$$\boxed{\theta = 60^\circ}$$ Ans



Ans. b

Solution: 8

$$\tan\phi' = \frac{\tan\phi}{\cos\theta}$$

$\theta = 30^\circ$ ; $\phi = 60^\circ$

so; $\tan\phi' = \frac{\tan 60^\circ}{\cos 30^\circ} = \frac{\sqrt{3}}{\sqrt{3}/2}$

$\tan\phi' = 2$

$\therefore$ New dip $\boxed{\phi' = \tan^{-1}(2)}$ deg.



Ans. b

## Solution: 9

$$\tan\phi' = \frac{\tan\phi}{\cos\theta}$$

$\theta = 60°$ ; $\phi = 30°$

so; $\tan\phi' = \frac{\tan 30°}{\cos 60°} = \frac{1/\sqrt{3}}{1/2}$

$\tan\phi' = 2/\sqrt{3}$

$\therefore$ New dip $\boxed{\phi' = \tan^{-1}\left(\frac{2}{\sqrt{3}}\right)}$ Ans.



Ans. c

# Solution: 10

$$\tan\phi' = \frac{\tan\phi}{\cos\theta}$$

$\theta = 30^\circ$ ; $\phi' = 45^\circ$

so; $\tan 45^\circ = \dfrac{\tan\phi}{\cos 30^\circ}$ $\Rightarrow$ $\tan\phi = \dfrac{\cos 30^\circ}{\tan 45^\circ}$

$$\tan\phi = \frac{\sqrt{3}/2}{1}$$

$$\Rightarrow \tan\phi = \frac{\sqrt{3}}{2}$$

$$\boxed{\phi = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)}$$ Ans



Ans. b

## Solution: 11

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$T \propto \frac{1}{\sqrt{B}}$$

given; $f_1 = 30$ oscilation/min $= \frac{30}{60}$ oscillations/sec

$f_1 = \frac{1}{2}$ oscillation/sec

$T_1 = \frac{1}{f_1} = 2$ sec

so; $\frac{T_1}{T_2} = \sqrt{\frac{B_2}{B_1}} \Rightarrow \frac{2}{T_2} = \sqrt{\frac{2B}{B}} \Rightarrow T_2 = \frac{2}{\sqrt{2}}$ sec

$$\boxed{T_2 = \sqrt{2}\ \text{sec}}$$



Ans. d

# Solution: 12

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$\Rightarrow f = \frac{1}{2\pi}\sqrt{\frac{MB}{I}}$$

$$f \propto \sqrt{B} \quad ; \; B_2 = 1.21B_1$$

$$\frac{f_1}{f_2} = \sqrt{\frac{B_1}{B_2}} = \sqrt{\frac{B_1}{1.21B_1}} = \sqrt{\frac{1}{1.21}} = \sqrt{\frac{100}{121}}$$

$$\frac{f_1}{f_2} = \frac{10}{11} \Rightarrow \frac{f_2}{f_1} = \frac{11}{10}$$

$$\Rightarrow \frac{f_2}{f_1} - 1 = \frac{11}{10} - 1$$

$$\frac{f_2 - f_1}{f_1} = \frac{1}{10}$$

$$\frac{\Delta f}{f_1} = \frac{1}{10}$$

$$\frac{\Delta f}{f_1} \times 100 = \frac{1}{10} \times 100$$

$$\frac{\Delta f}{f_1}\% = 10\%$$

$\therefore$ f increases by 10%



Ans. a

## Solution: 13

Time period of oscillations $T = 2\pi\sqrt{\frac{I}{MB}}$

$$T = 2\pi\sqrt{\frac{7.5\times10^{-6}}{6.7\times10^{-2}\times0.01}} = 2\pi\sqrt{\frac{7.5}{6.7}\times10^{-2}}$$

$$T = 2\pi\sqrt{\frac{7.5}{6.7}}\times10^{-1} = 6.65\times10^{-1}\ \text{sec}$$

Time taken for 10 complete oscillations = 10T

$$= 10\times6.65\times10^{-1}$$

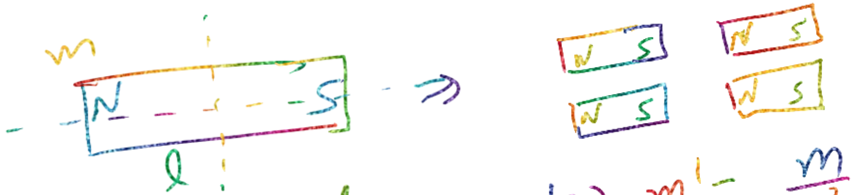
$$= 6.65\ \text{sec}$$

Ans.



Ans. b

## Solution: 14



$M = ml$

Let mass $= w$

$\therefore I = \frac{wl^2}{12}$

$T = 2\pi\sqrt{\frac{I}{MB}}$

Now $m' = \frac{m}{2}$

& $l' = \frac{l}{2}$

$\Rightarrow M' = \frac{m}{2}\frac{l}{2} = \frac{M}{4}$

$I' = \frac{\left(\frac{w}{4}\right)\left(\frac{l}{2}\right)^2}{12} = \frac{wl^2}{12} \times \frac{1}{16} = \frac{I}{16}$

$\frac{T_1}{T_2} = \sqrt{\frac{I_1}{I_2}} \times \sqrt{\frac{M_2}{M_1}} = \sqrt{\frac{I}{I/16}} \times \sqrt{\frac{M/4}{M}}$

$\frac{T_1}{T_2} = \sqrt{16} \times \sqrt{\frac{1}{4}} = 4 \times \frac{1}{2} = 2$

$\boxed{T_2 = \frac{T_1}{2}}$ Ans.

Ans. c

## Solution: 15

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

I & B are constant in Both cases

$$\therefore \quad T \propto \frac{1}{\sqrt{M}}$$

$$M_1 = M + 2M = 3M$$

$$\& \quad M_2 = 2M - M = M$$

So; $$\frac{T_1}{T_2} = \sqrt{\frac{M_2}{M_1}} = \sqrt{\frac{M}{3M}} = \frac{1}{\sqrt{3}}$$

$$T_2 = \sqrt{3}\,T_1$$

$$\boxed{T_2 = 3\sqrt{3}\ \text{sec}}$$ Ans.



Ans. b

Solution: 16

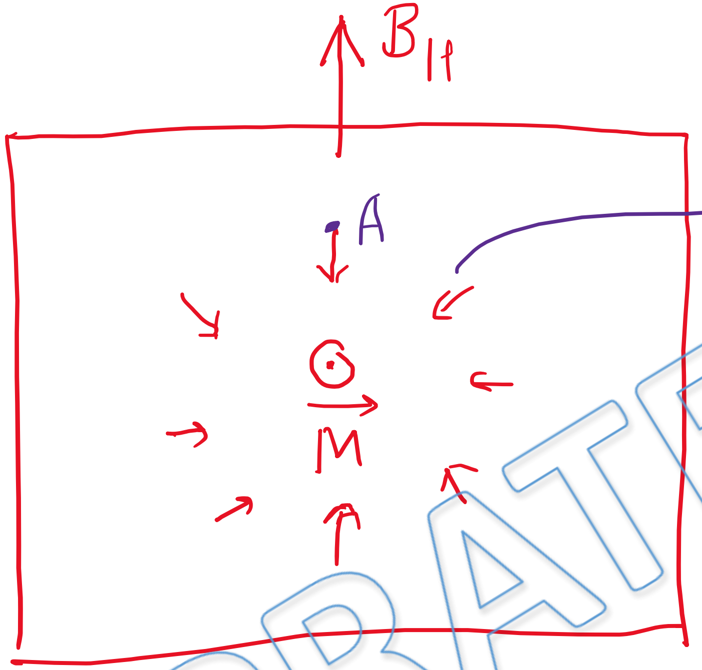
There is no horizontal component of field in the plane perpendicular to magnetic meridian So net field in this plane is in vertical direction.

$\Rightarrow$ needle indicates in vertical direction.



Ans. a

# Solution: 17




→ horizontal component of field due to magnet.

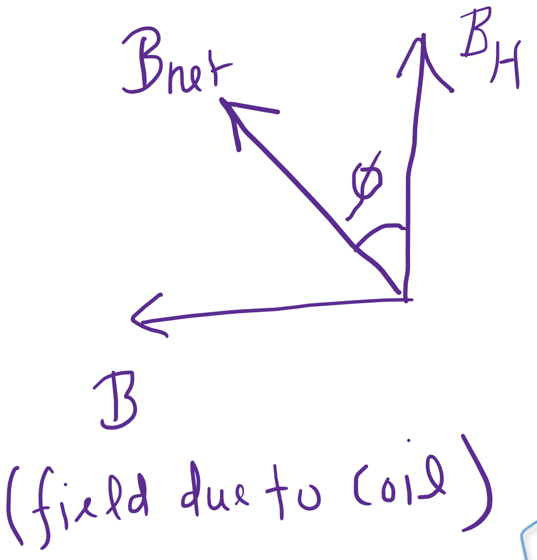
There is only one point "A" in the plane of paper where horizontal component of field of magnet is just opposite to $B_H$.

Ans (a)



Ans. a

## Solution: 18




$\phi \rightarrow$ deflection

$$\tan\phi = \frac{B}{B_H}$$

$$\Rightarrow B = B_H \tan\phi$$

$$= .34 \times 10^{-4} \tan 30^{\circ}$$

$$= \frac{3.4}{\sqrt{3}} \times 10^{-5}$$

$$= 1.96 \times 10^{-5}\ T$$

Ans. b

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