Physicsaholics

DPP – 5 (Magnetic Field & Force)

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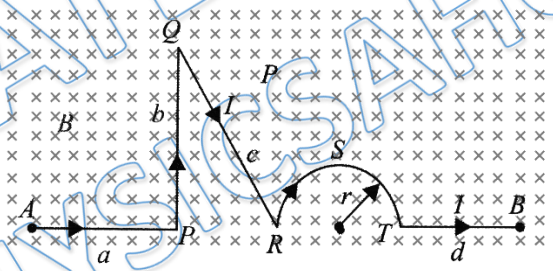
Q 1. Two free parallel wires carrying currents in opposite direction
(a) Attract each other
(b) Repel each other
(c) Neither attract nor repel
(d) Get rotated to be perpendicular to each other

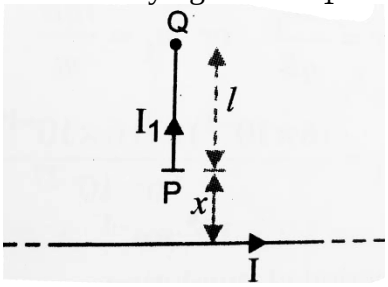
Q 2. If the distance between two parallel current carrying wires is doubled, what is the force between them?
(a) Become double of initial value
(b) Become half of initial value
(c) Become four time of initial value
(d) Become one fourth of initial value

Q 3. Calculate the force on a current (I) carrying wire in a uniform magnetic field (B) as shown in Fig:



(a) $IB\left(a+2r+d+\sqrt{c^2-b^2}\right)$
(b) $IB(a+b+c+\pi r+d)$
(c) $IB\left(a+\pi r+d+\sqrt{c^2-b^2}\right)$
(d) Zero

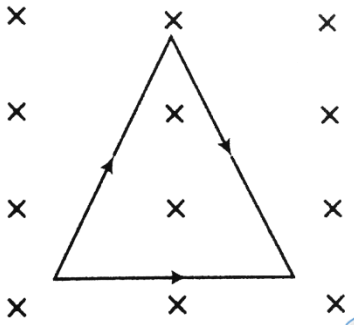
Q 4. Find the force on the conductor carrying current I_1 as shown in figure



(a) $\frac{\mu_0 I I_1}{4\pi}\ln\left(\frac{l+x}{l}\right)$

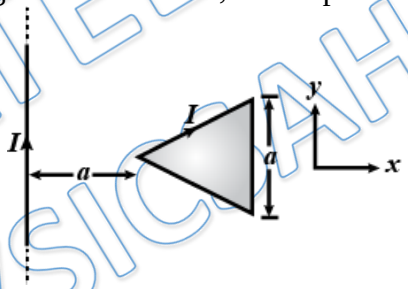
(b) $\frac{\mu_0 I I_1}{2\pi} \ln\left(\frac{l}{l+x}\right)$
(c) $\frac{\mu_0 I I_1}{2\pi} \ln\left(\frac{l+x}{x}\right)$
(d) $\frac{\mu_0 I I_1}{4\pi} \ln\left(\frac{x}{l+x}\right)$

Q 5. Find net force on the equilateral loop of side `4 m` carrying a current of `2 A` kept in a uniform magnetic field of `2 T` as shown in figure.



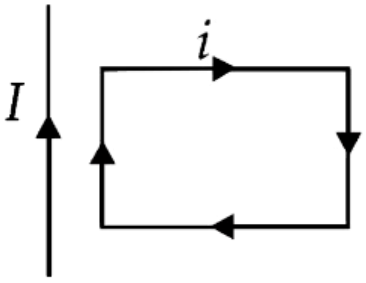
(a) Zero
(b) 32 N
(c) 16 N
(d) 8 N

Q 6. An equilateral triangular loop is kept near to a current carrying long wire as shown fig. under the action of magnetic force alone, the loop



(a) must move along positive or negative X-axis
(b) must move in XY plane and not along X- or Y-axis
(c) does not move
(d) moves but which way we cannot predict

Q 7. A rectangular loop carrying a current i is situated near a long straight wire such that the wire is parallel to the one of the sides of the loop and is in the plane of the loop. If a steady current I is established in wire as shown in figure, the loop will

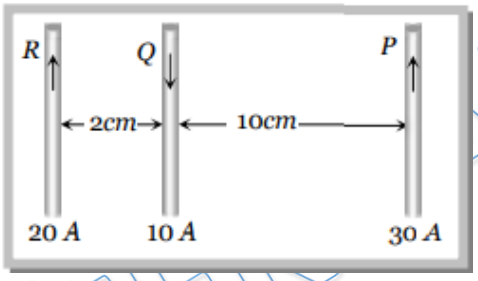


(a) Rotate about an axis parallel to the wire
(b) Move away from the wire or towards right
(c) Move towards the wire
(d) Remain stationary

Q 8. Through two parallel wires A and B, 10 and 2 ampere of currents are passed respectively in opposite direction. If the wire A is infinitely long and the length of the wire B is 2 m, the force on the conductor B, which is situated at 10 cm distance from A will be

(a) 8×10^{-5}N (b) 4×10^{-7}N
(c) 4×10^{-5}N (d) $4\pi \times 10^{-7}$N

Q 9. Three long, straight and parallel wires carrying currents are arranged as shown in figure. The force experienced by 10 cm length of wire Q is:

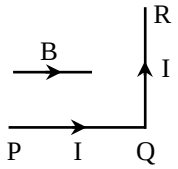


(a) 1.4×10^{-4}N towards the right
(b) 1.4×10^{-4}N towards the left
(c) 2.6×10^{-4}N towards the right
(d) 2.6×10^{-4}N towards the left

Q 10. A current of 5 ampere is flowing in a wire of length 1.5 meters. A force of 7.5 N acts on it when it is placed in a uniform magnetic field of 2 Tesla. The angle between the magnetic field and the direction of the current is

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

Q 11. A wire PQR is bent as shown in figure and is placed in a region of uniform magnetic field B. The length of PQ = QR = l. A current I ampere flows through the wire as shown. The magnitude of force on PQ and QR will be -



(a) Bil , 0 (b) $2Bil$, 0
(c) 0, Bil (d) 0, 0

Q 12. A rectangular coil 20cm × 20cm has 100 turns and carries a current of 1 A. It is placed in a uniform magnetic field B = 0.5 T with the direction of magnetic field parallel to the plane of the coil. The magnitude of the torque required to hold this coil in this position is

(a) Zero (b) 200 N-m

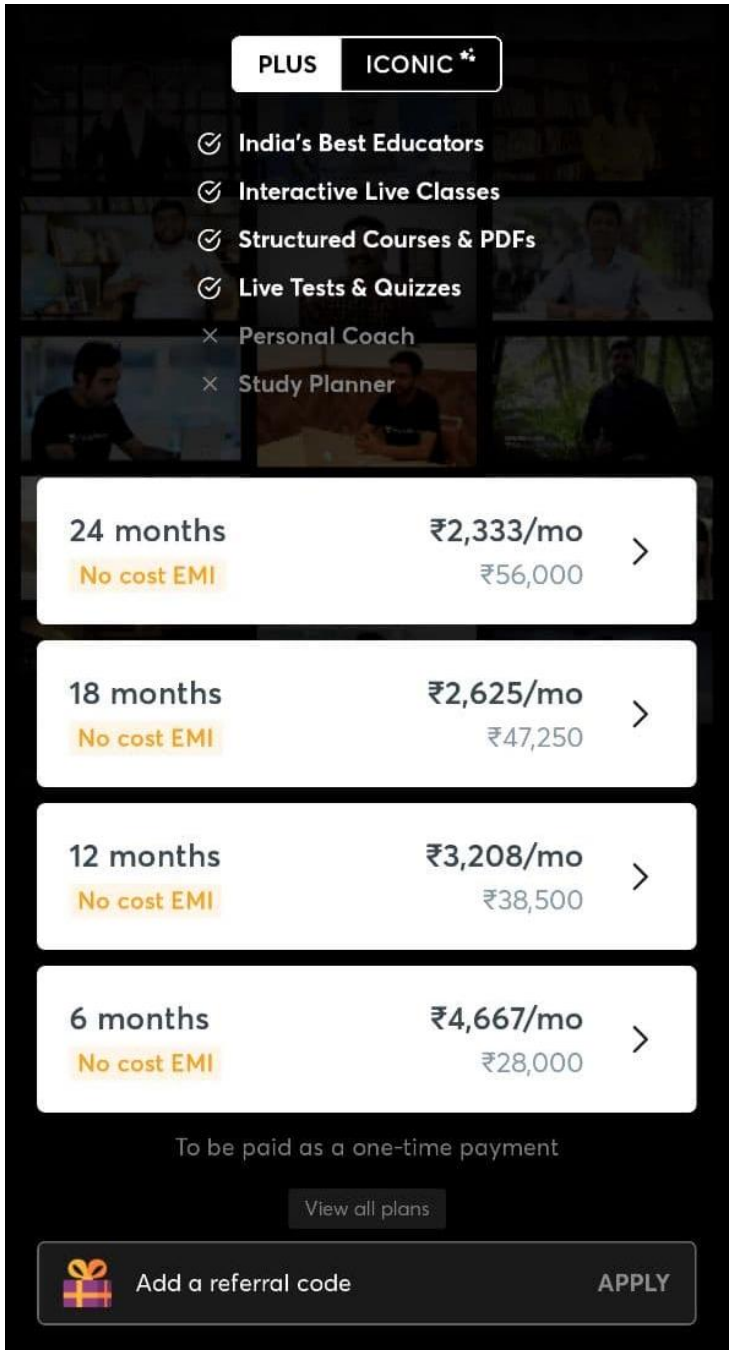
(c) 2 N-m (d) 10 N-m

Q 13. A circular coil of 20 turns and radius 10 cm carries a current of 5A. It is placed in a uniform magnetic field of 0.10T. Find the torque acting on the coil when the magnetic field is applied (a) normal to the plane of the coil (b) in the plane of coil
(a) zero, 0.314 N-m (b) 3.14 N-m, zero
(c) 0.314 N-m, zero (d) zero, 3.14 N-m

Q 14. A circular coil of 100 turns radius 10cm, carries a current of 5A. It is suspended vertically in a uniform horizontal magnetic field of 0.5T and the field lines make an angle of 60^0 with the plane of the coil. The magnitude of the torque that must be applied on it to prevent it from turning is:
(a) 2.93 N-m (b) 3.41 N-m
(c) 3.93 N-m (d) 4.93 N-m

Answer Key

Q.1 b	**Q.2 b**	**Q.3 a**	**Q.4 c**	**Q.5 b**
Q.6 a	**Q.7 c**	**Q.8 a**	**Q.9 a**	**Q.10 a**
Q.11 c	**Q.12 c**	**Q.13 a**	**Q.14 c**	



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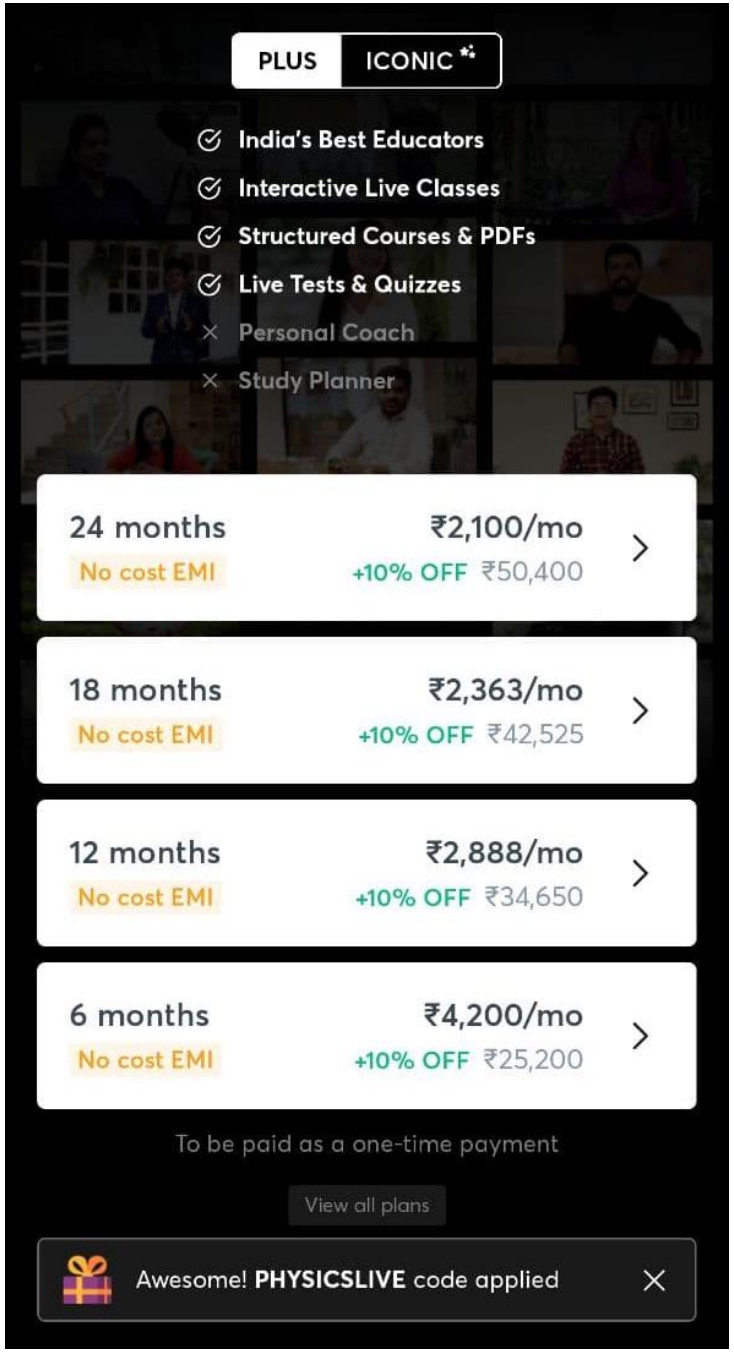
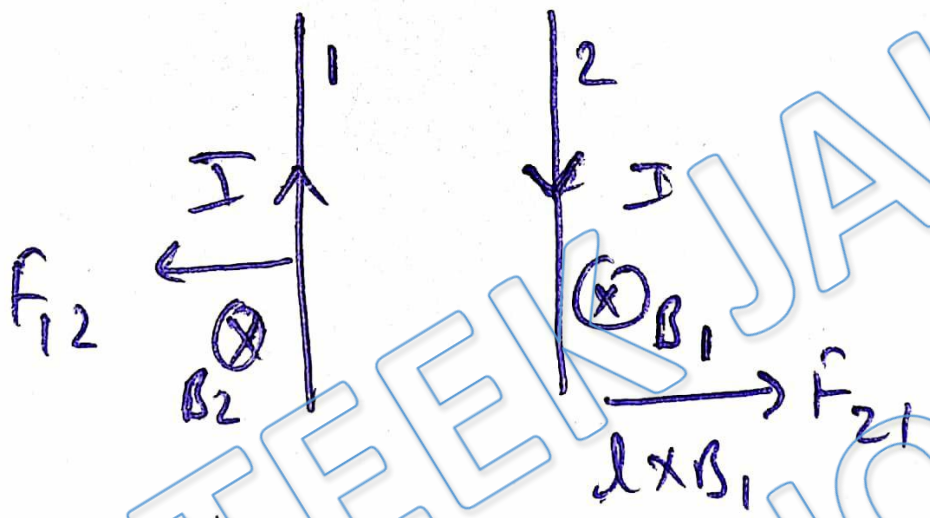


Written Solution

DPP- 5 Current Carrying Conductor in Magnetic Field

By Physicsaholics Team

Solution: 1



If two parallel wires carry current in opposite directions, they repel each other

Ans. b

Solution: 2

$$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$F \propto \frac{1}{d}$$

when $d' = 2d$

$$\frac{F_1}{F_2} = \frac{d_2}{d_1}$$

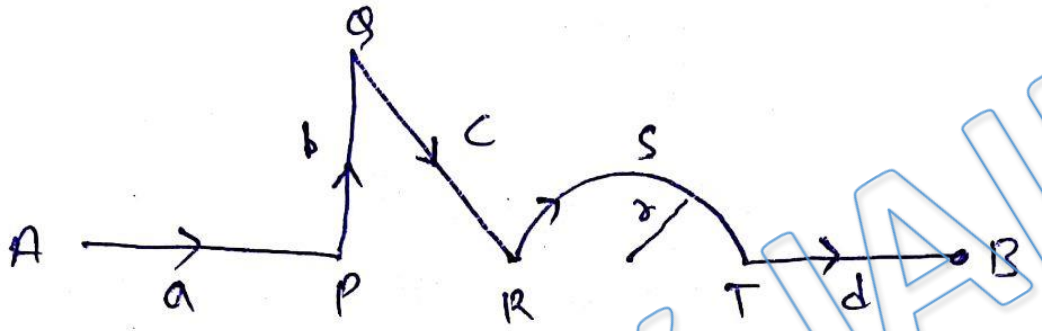
$$\frac{F}{F_2} = \frac{2d}{d}$$

$$\boxed{F_2 = \frac{F}{2}}$$

Ans. b

Solution: 3

$$\vec{F} = I(\vec{L} \times \vec{B})$$



$$L = AP + PR + RT + TB$$

$$L = a + \sqrt{c^2 - b^2} + 2r + d$$

$\because$ L & B are $\perp$

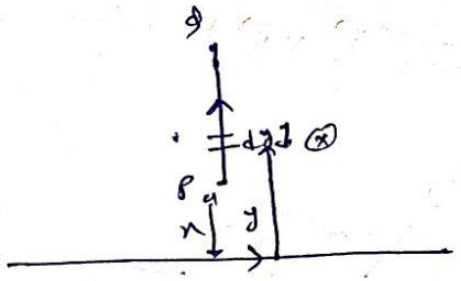
So; $F = BIL$

$$\boxed{F = IB\left(a + \sqrt{c^2 - b^2} + 2r + d\right)}$$

$$\boxed{F = IB\left(a + \sqrt{c^2 - b^2} + 2r + d\right)}$$

Ans. a

Solution: 4



B due I at distance 'y'

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

force due to B on element of length dl

$$dF = I\,(dl)\,(B)$$

$$dF = I_1 B\,dy = I_1\left(\frac{\mu_0 I}{2\pi y}\,dy\right)$$

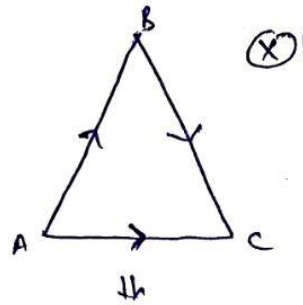
$$\int_0^F dF = \frac{\mu_0 I I_1}{2\pi}\int_x^{l+x}\frac{dy}{y}$$

$$F = \frac{\mu_0 I I_1}{2\pi}\left(\ln y\right)_x^{l+x}$$

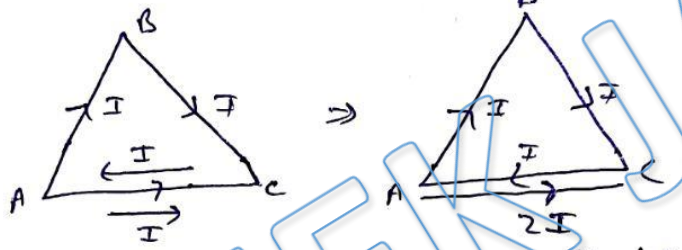
$$\boxed{F = \frac{\mu_0 I I_1}{2\pi}\ln\left(\frac{l+x}{x}\right)}$$

Ans. c

Solution: 5



⊗B



So; net force on loop will be equal to the net force on branch 'AC' with current '2I'

∴ with current 'I' ABC is making closed loop (there f=0)

So; $F = F_{AC}$ (current = 2I)

$F = BIl$

$I \to 2I$

$F = B(2I)l$

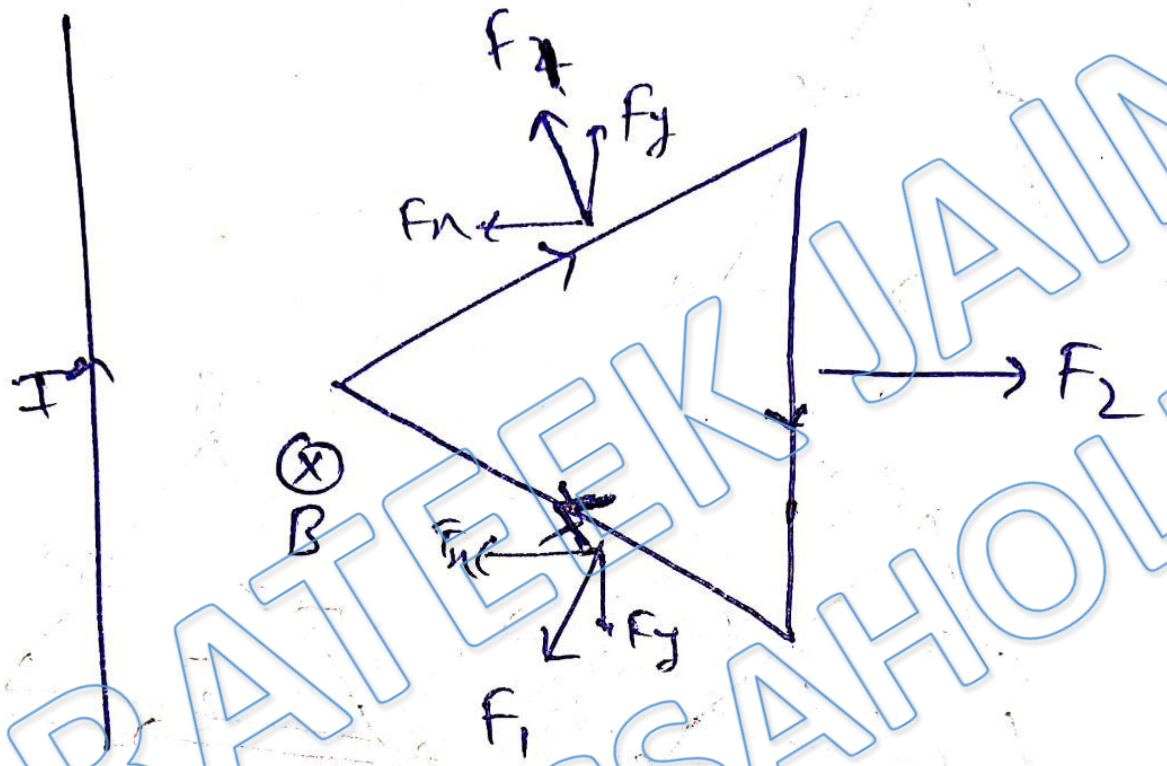
$\boxed{F = 2BIl}$

$F = 2 \times 2 \times 2 \times 4$

$\boxed{F = 32\ N}$

Ans. b

Solution: 6

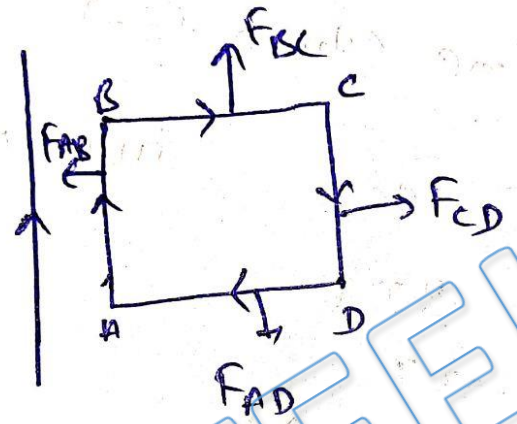


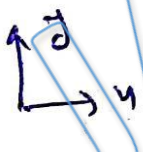
So, net force acting on the loop would be along x-axis

So, it will move along x-axis.

Ans. a

Solution: 7





as $F_{BC} = F_{AD}$ (F_{net} in y-dir = 0)

$\Rightarrow F_{AB} > F_{CD}$

(∵ Magnetic field at AB is more than that at CD)

$\therefore F_{net} = F_{AB} - F_{CD}$

towards wire.

Ans. c

Solution: 8

$$F = \frac{\mu_0 I_1 I_2 l}{2\pi d}$$

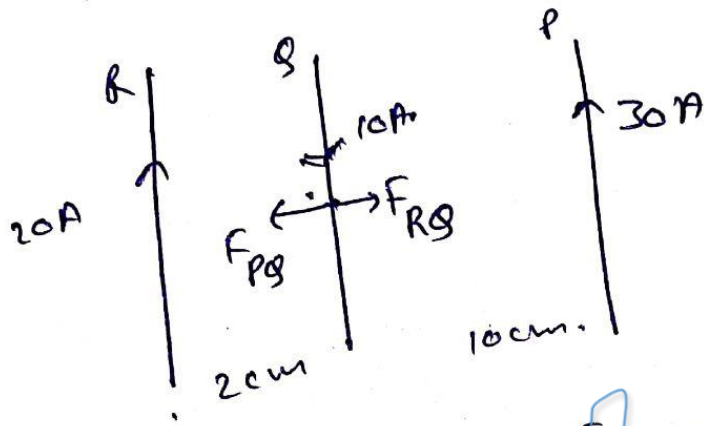
$$F = \frac{4\pi \times 10^{-7} \times 10 \times 2 \times 2}{2\pi \times (10 \times 10^{-2})}$$

$$F = \frac{8 \times 10 \times 10^{-7}}{10 \times 10^{-2}}$$

$$\boxed{F = 8 \times 10^{-5}\ N}$$

Ans. a

Solution: 9



$$F_{net} = F_{QR} - F_{QP}$$

$$= \frac{\mu_0 (20)(10) \times 10 \times 10^{-2}}{2\pi \times (2 \times 10^{-2})} - \frac{\mu_0 (10 \times 30) \times (10 \times 10^{-2})}{2\pi (10 \times 10^{-2})}$$

$$F_{net} = \frac{\mu_0}{2\pi} \left(\frac{2000}{2} - \frac{3000}{10} \right)$$

$$F_{net} = \frac{2 \times 10^{-7}}{2} \left(\frac{1400}{10} \right)$$

$$F_{net} = 2 \times 10^{-7} \times \frac{1400}{2}$$

$$F_{net} = 1.4 \times 10^{-4} N$$

$$\boxed{F_{net} = 1.4 \times 10^{-4} N} \quad \text{(right)}$$

Ans. a

Solution: 10

$$F = BIl\sin\theta$$

$$7.5 = 2 \times 5 \times 1.5 \sin\theta$$

$$7.5 = 2 \times (7.5) \sin\theta$$

$$\sin\theta = \frac{1}{2}$$

$$\boxed{\theta = 30^\circ}$$

Ans. a

Solution: 11

Sol. $F = I B \ell \sin\theta$

$F_{PQ} = IB\ell \sin 0° = 0$

$F_{QR} = IB\ell \sin 90° = IB\ell$

Ans. c

Solution: 12

$$\tau = NBIA$$

$$\tau = 100 \times 0.5 \times 1 \times (20 \times 20 \times 10^{-4})$$

$$\tau = 50 \times 400 \times 10^{-4}$$

$$\tau = 20,000 \times 10^{-4}$$

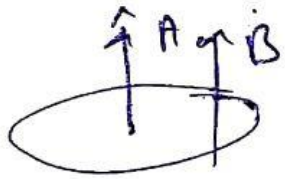
$$\boxed{\tau = 2 \text{ N-m}}$$

Ans. c

Solution: 13

$\tau = NBIA \sin\theta$ (θ = angle between area vector and $\vec{B}$)

(a)



$\theta = 0$

or

$\theta = 180^\circ$

$\tau = NBIA \sin 0^\circ$

or

$NBIA \sin(180^\circ)$

$\boxed{\tau = 0}$

(b)

$\tau = NBIA \sin 90^\circ$

$\tau = NBIA$

$\tau = 20 \times 0.1 \times 5 \times \pi \times (10 \times 10^{-2})^2$

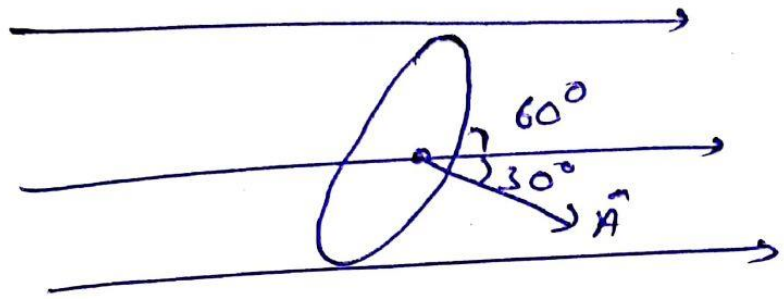
$\tau = 2 \times 1 \times \pi \times (10^{-1})^2$

$\tau = 10 \times 3.14 \times 10^{-2}$

$\boxed{\tau = 0.314 \text{ N-m}}$

Ans. a

Solution: 14



$\theta = 30°$

$\tau = NBIA\sin\theta$

$= 100 \times 0.5 \times 5 \times \pi \times (10 \times 10^{-2})^2 \times \sin 30°$

$= 50 \times 5 \times \pi \times (10^{-1})^2 \times \frac{1}{2}$

$= 250 \times \pi \times 10^{-2} \times \frac{1}{2}$

$= \frac{2.5}{2} \times \pi = 1.250 \times \pi$

$\tau = 1.25 \times \pi$

$\boxed{\tau = 3.93 \text{ N-m}}$

Ans. c

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