PHYSICS

1. (4)
   (i) When no field is present E = 0, B = 0, the proton experiences no force. Thus it moves with a constant velocity.
   (ii) When E = 0 and B ≠ 0, then there will be a probability that proton may move parallel to magnetic field. In this situation, there will be no force acting on proton.
   (iii) When both fields are present E ≠ 0, B ≠ 0, then let E, B and v may be mutually perpendicular to each other. In this case, the electric and magnetic forces acting on the proton may be equal and opposite. Thus, there will be no resultant force on the proton.

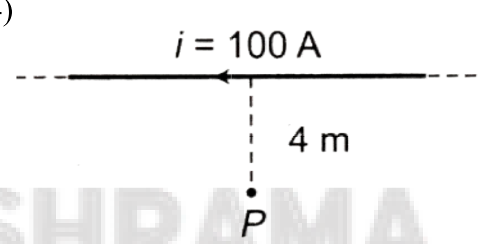
2. (3)
   The magnetic field due to both the coils are in the same direction and equal in magnitude
   The magnitude of the magnetic field due to one coil is give as
   $$B = \frac{\mu_0 i R^2}{2\left(R^2 + \left(\frac{R}{2}\right)^2\right)^{\frac{3}{2}}}$$
   $$B = \frac{4\mu_0 i R^2}{5R^2}$$
   $B_{net} = 2B$
   $$B_{net} = \frac{8\mu_0 i R^2}{5R^2}$$

3. (1)
   $N = 1000 \text{ turns cm}^{-1}$
   $$H = \frac{NI}{1} \Rightarrow 100\frac{A}{M} = \frac{100 \times I}{10^{-2}}$$
   $\Rightarrow 100A = 10^5 \times I \Rightarrow 10^{-3} A = I$
   $\Rightarrow I = 1 \text{ mA}$

4. (4)
   As we can see, the forces meet at a point. So, even if we turn the loop along any axis, the net torque will bring it back to its initial position. Hence it is in stable equilibrium.

5. (4)
   Hysteresis loop with more area signifies a 'hard' ferromagnetic material and hysteresis loop with less area signifies a 'soft' ferromagnetic material. Hence, A is good for electromagnets and B is good for electric generators.

6. (4)



   $$B = \frac{\mu_0 i}{2\pi d} = \frac{2 \times 10^{-7} \times 100}{4} = 5 \times 10^{-6} \text{ T, South}$$

7. (2)
   When $\vec{E}$ and $\vec{B}$ are perpendicular and velocity has no change then $qE = qvB$
   i.e., $v = \frac{E}{B}$.
   The two forces oppose each other so, v is along $\vec{E} \times \vec{B}$ i.e., $\vec{v} = \frac{\vec{E} \times \vec{B}}{B^2}$

8. (2)
   Equating magnetic force to centripetal force, $\frac{mv^2}{r} = qvB\sin 90°$
   Time to complete one revolution, $T = \frac{2\pi r}{v} = \frac{2\pi m}{qB}$

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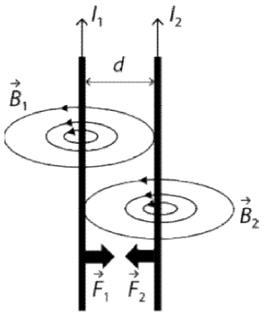
9. (3)

The force per unit length between two long current carrying conductors is

$F = \frac{\mu_0 i_1 i_2}{2\pi d}$, where d is the distance between the conductors and i_1 and i_2 are the currents carried by the conductors.



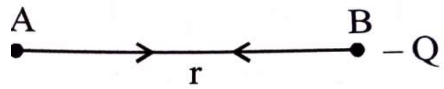
The conductors attract each other if i_1 and i_2 are in the same direction. Magnetic field created by conductor 1 at the location of the conductor 2 and conductor 2 gets attracted towards conductor 1.

Since $i_1 = i_2 = i$

$\therefore F = \frac{\mu_0 i^2}{2\pi d}$

10. (2)

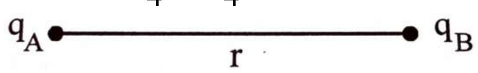
We know that, $F = \frac{kQ^2}{r^2} + Q$



If 25% of charges of A transfer to B then

$q_A = Q - \frac{Q}{4} = \frac{3Q}{4}$ and

$q_B = -Q + \frac{Q}{4} = \frac{-3Q}{4}$



$F_1 = \frac{kq_A q_B}{r^2}$

$\Rightarrow F_1 = \frac{k\left(\frac{3Q}{4}\right)^2}{r^2} = \frac{9}{16}\frac{kQ}{r^2} = \frac{9F}{16}$

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