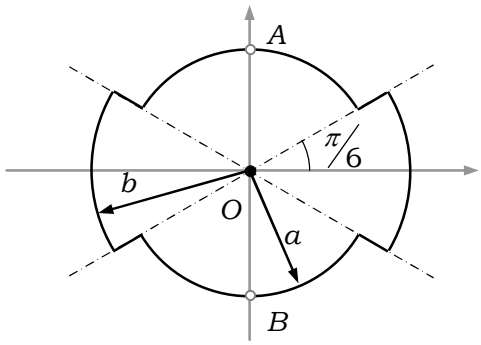
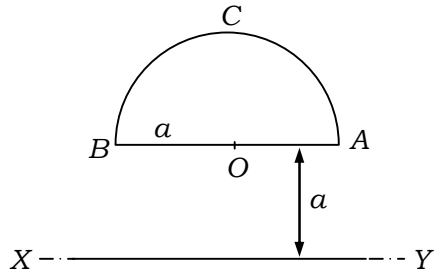
ADDITIONAL EXERCISE

1. There exists a long conductor along z-axis carrying a current of 5 A along –ve z direction. Find the total torque on the loop (symmetrical about x and y axes) in xy-plane as shown in the diagram. Resistance per unit length of the wire forming loop equals 2 Ω/m. Potential difference V_{BA} = 28 volts. Radii a = 0.6 m & b = 0.9 m as shown.



Answer :

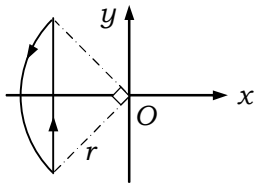
2. A wire $ACBOA$ shaped as a semi circle ACB with the bounding diameter BOA with $OA = OB = OC = a$, has a resistance R. It is placed in the same plane as an infinitely long wire XY with AB parallel to XY at a distance a and C further away from XY. A total charge Q flows through XY such that the current in XY decreases linearly from an initial value to 0 in time T. Find



a) Current in XY as a function of time.
b) magnetic flux through $ACBOA$ when current in XY is i.
c) Induced current in $ACBOA$ as a function of time.
d) Heat generated in $ACBOA$ in time T.
e) Force acting on ACB as a function of time.

Answer :

3. A wire loop carrying a current i is placed in the x-y plane as shown in figure. A particle of mass m and charge q is placed at origin and given a velocity $\vec{\mathbf{v}} = \frac{v_0}{\sqrt{2}}\left(\hat{\mathbf{i}} + \hat{\mathbf{j}}\right)$ m/s. Find

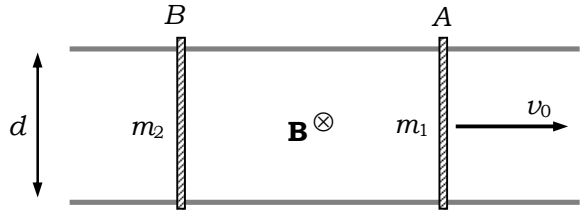


a) instantaneous acceleration

b) If an external magnetic field $\vec{\mathbf{B}} = B_0\hat{\mathbf{i}}$ is applied, find the force and torque acting on the loop due to this field.

Answer :

4. Two straight conductors A and B of masses m_1 and m_2 and resistance R each are placed on two parallel smooth rails at separation d as shown in figure. There exists a uniform magnetic field B perpendicular to the plane of the figure. At $t = 0$, the conductor A is given a velocity v_0 perpendicular to it along the rails. Find the velocity of the two conductors as a function of time.



Answer :

5. Two wires P and Q of same area of cross-section and lengths 3ℓ and ℓ respectively, are join in parallel to form a circular loop. When the two ends are connected with a battery, the net magnetic field at the centre of the circular loop is B due to loop. Find the ratio of specific resistance of the wire P to wire Q.

Answer :

6. A disc of radius R rotates at an angular velocity ω about the axis perpendicular to its surface and passing through its centre. If the disc has a uniform surface charge density σ, find the magnetic induction on the axis of rotation at a distance x from the centre.

Answer : $B = \dfrac{\mu_o\sigma\omega}{2}\left\{\dfrac{R^2+2x^2}{\sqrt{R^2+x^2}} - 2x\right\}$

7. Find magnetic field at the centre of a tightly wound spiral of inner radius a, outer radius b made of uniform insulated wire with wire diameter c carrying a current i.

Answer :

8. A charge particle of mass m and charge q, experiences an acceleration a eastwards when it is released from rest at a particular place. When it is projected with a velocity v northwards at the same place it experiences an acceleration a westwards. Find the strength of magnetic field at that place.

Answer :

9. A Potential difference of 600 V is applied across the plates of a parallel plate capacitor. The separation between the plates is 3 mm. An electron projected vertically, parallel to the plates, with a velocity of 2×10^6 m/s moves undeflected between the plates. Find the magnitude and direction of magnetic field in the region between the capacitor plates.

Answer : $B = 0.1$ T

10. A conducting rod of mass 0.1 kg and length 0.25 m lies on a horizontal rough table surface and normal to a uniform horizontal magnetic field of induction 0.20 T. If a current of 10 A passed through the rod and coefficient of kinetic friction = 0.1. Find
    a) horizontal force required to be applied perpendicular to the length of the rod to keep it in uniform velocity over the table.
    b) If the magnetic field is vertical, find the current i in the rod to have a uniform velocity over the table.

Answer : a) 0.1 ± 0.05 N; b) $I = 2$ amp.

11. A proton, a deuteron and an α-particle, accelerated through the same potential difference, enter a region of uniform magnetic field, moving at right angles to B. Find the ratio of radii of their circular paths.

Answer : $1 : \sqrt{2} : \sqrt{2}$

12. A proton (charge $q = 1.6 \times 10^{-19}$ C, mass $m = 1.67 \times 10^{-27}$ kg) is shot with a speed 8×10^6 ms^{-1} at an angle of 30° with the x-axis. A uniform magnetic field $B = 0.30$ T exists along the x-axis. Show that the path of the proton is helix. Find the radius of the helix.

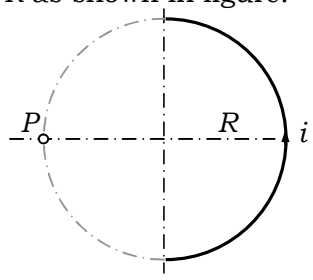
Answer : $\frac{5}{36}$ m

13. A plastic disk of radius R has a charge q uniformly distributed over its surface. If the disk is rotated at an angular frequency ω about its axis, show that

a) the induction at the center of the disk is $B = \frac{\mu_o \omega q}{2\pi R}$

b) the magnetic dipole moment of the disk is $\mu = \frac{\omega q R^2}{4}$

14. Find magnetic field at a point P, symmetrically placed on the periphery, due to semicircular wire of radius R as shown in figure.



Answer : $\frac{\mu_o}{4\pi}\frac{i}{R}\ln\left(1+\sqrt{2}\right)$